Instruments

THE MAGAZINE OF MEASUREMENT
INSPECTION · TESTING · CONTROL

UNIVERSITY

luding the

JOURNAL OF THE INSTRUMENT SOCIETY OF AMERICA (Page 1429)

d the

JOURNAL OF THE SOUTHERN CALIFORNIA METER ASSOCIATION (Page 1441)

this issue . . .

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ulp and Paper Instrumentation
rifice Coefficients
strument Electronics
rifice Meter Runs
A Exhibit Pictorial
trasonic Viscometer
rtificial Weather
2 New Instruments
4 New Bulletins

Modern control room of the Mitchell Station, West Penn Power Co., Monongahela (near Pittsburgh) Pa. Photograph from Kirk and Blum, who fabricated the pump and heater control desks and the instrument panels.

l. 25 No. 10
CTOBER • 1952

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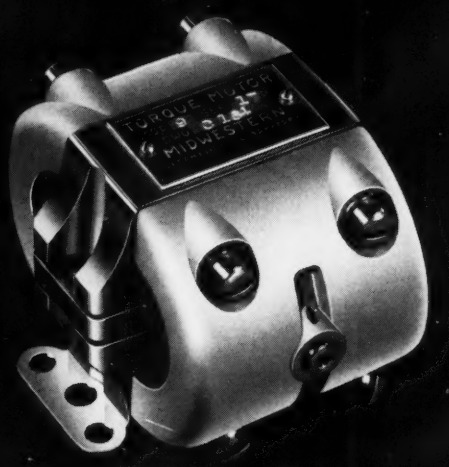
ANNOUNCING...

more power in a smaller package!



Shown Approximately Actual Size

MIDWESTERN MODEL 9 TORQUE MOTOR

A Precision Linear Electro-Mechanical Actuator

Midwestern's new, powerful linear actuator was designed primarily to stroke pistons in hydraulic servovalves. However, it is being enthusiastically accepted in many engineering fields as a basic transducer to convert a few watts of power from an electronic amplifier to a linear mechanical motion with considerable force. For complete engineering details on this new, small, powerful Model 9 Torque Motor, write or wire Midwestern Geophysical Laboratory.

SPECIFICATIONS

- Midposition Force ..... 9.5 lb
- Stroke ..... ±.015 in.
- Weight ..... 19 oz
- No-Load Natural Frequency ..... 425 cps
- Coil Resistance ..... 3400 ohms (each)
- Balance Current ..... 20 ma
- Differential Current (max.) ..... 40 oma

MIDWESTERN

3401 S. HARVARD AVE. — TULSA, OKLAHOMA

ADVANCED EN
K&M CO
M

K&M control valves are available in sizes from ½ to 20-inch, complete with diaphragm motor, and are made in 13 different types. Many construction modifications are available to exactly meet specific requirements.

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These and other features are described in detail in the new comprehensive K&M Control Valve catalog.
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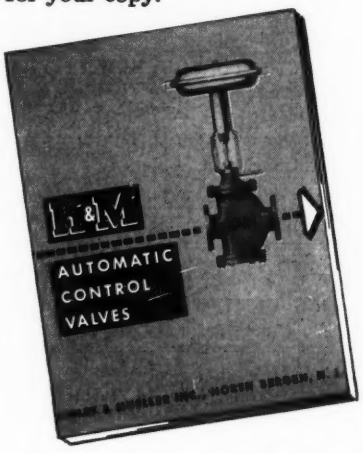

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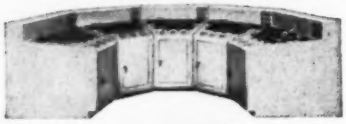
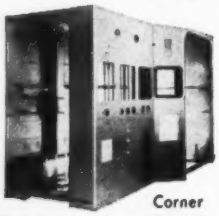


Benchboard Console



Five Section Cubicle Control Board and Lighting Canopy

Corner Cubicle Section

Refinery Cubicle with Mimic Flow Diagram in Color

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Instruments

THE MAGAZINE OF MEASUREMENT
INSPECTION · TESTING · CONTROL

Vol. 25 OCTOBER, 1952 No. 10

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***JOURNAL* of the INSTRUMENT SOCIETY OF AMERICA** 1429

***JOURNAL* of the SOUTHERN CALIFORNIA METER ASSOCIATION**

Orifice Meter Runs 1441
By W. A. Griffin

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Entered as second class matter, October 14, 1949, at the post office at Pontiac, Illinois, under the act of March 3, 1879.

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TO AIR FORCE SPECIFICATIONS

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2" Single, for ring clamp mounting. For cylinder temperature, range −50 to +300°C, Iron-Constantan.

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12 or 24 volt ratiometers

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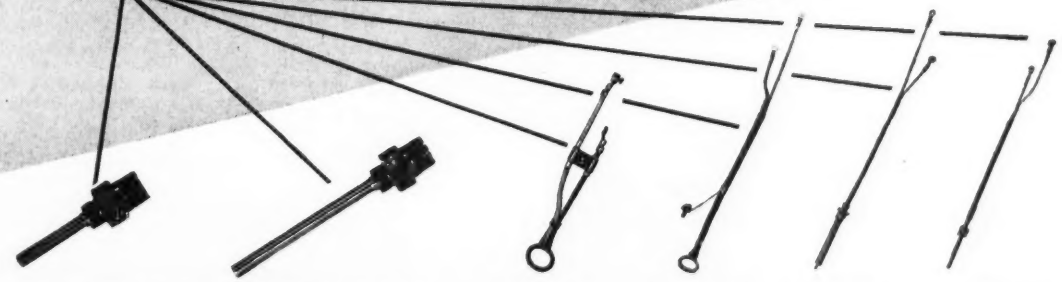

STANDARD AN5525-1 with 1⅞ in. stem | **STANDARD AN5525-2 with 4 in. stem** | **AN5540-1** | **AN5540-2** | **AN5545-1** | **AN5541-1**

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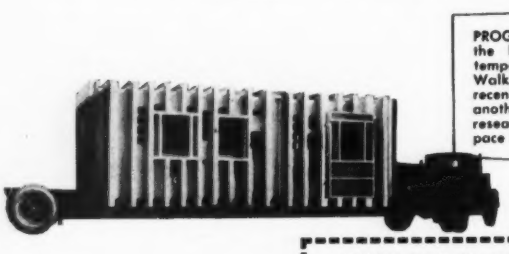

PROGRESS REPORT . . . One of the largest factory fabricated, temperature — altitude — humidity Walk-In rooms in the world was recently completed by Bowser — another example of how Bowser's research and production keep pace with scientific advancement.

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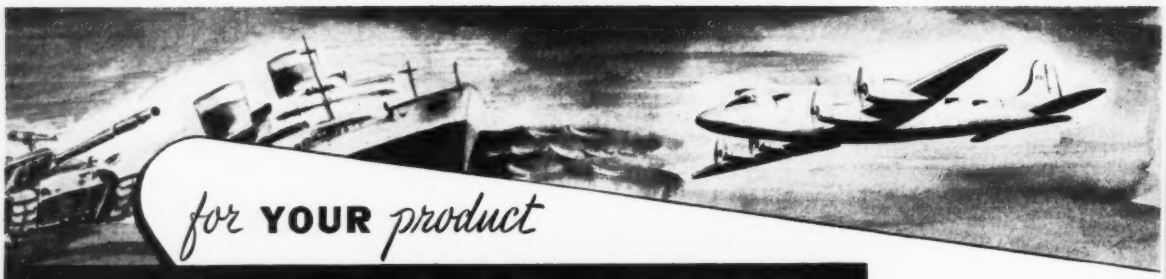

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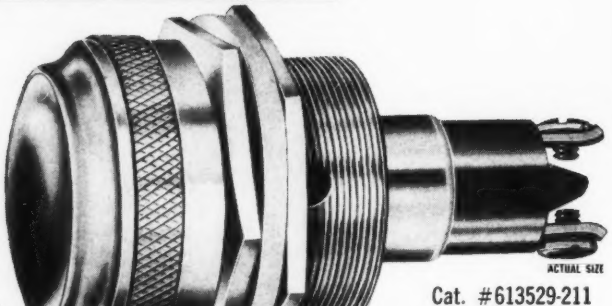

ACTUAL SIZE

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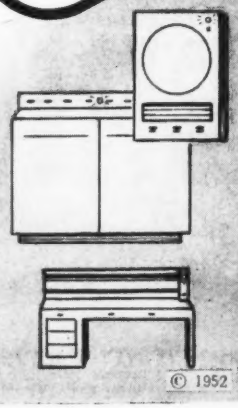

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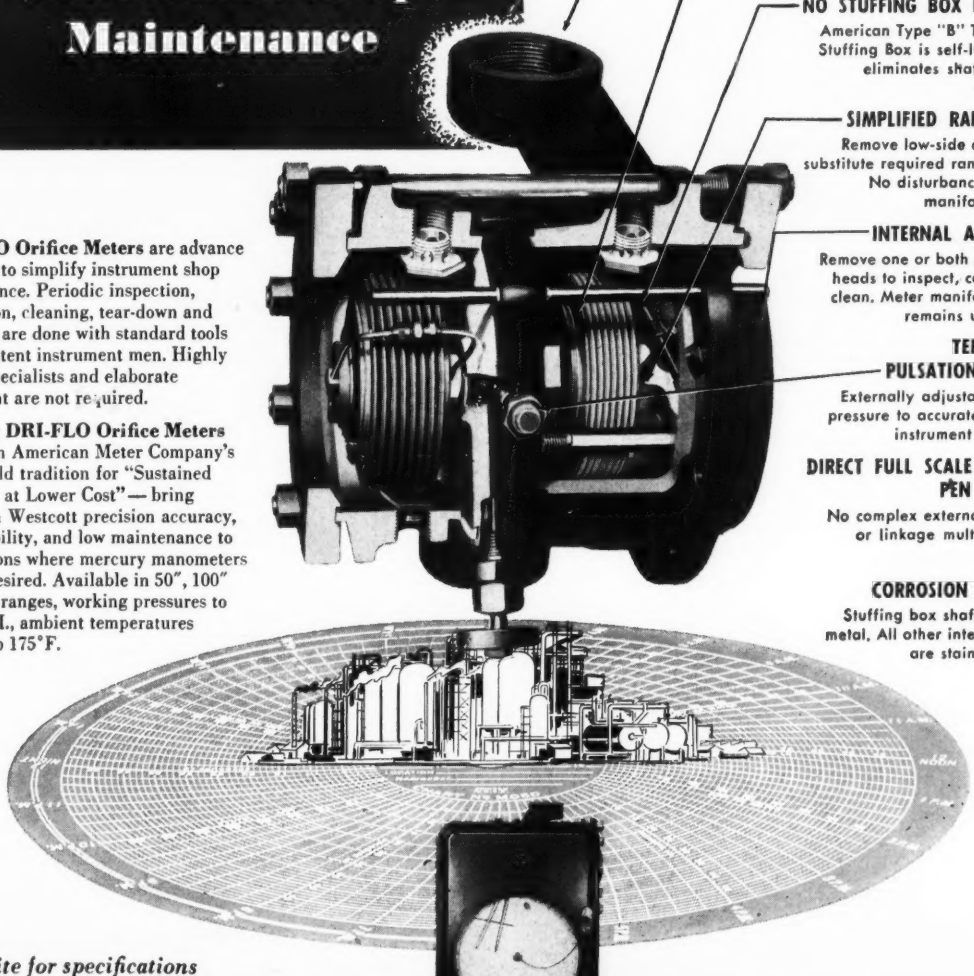

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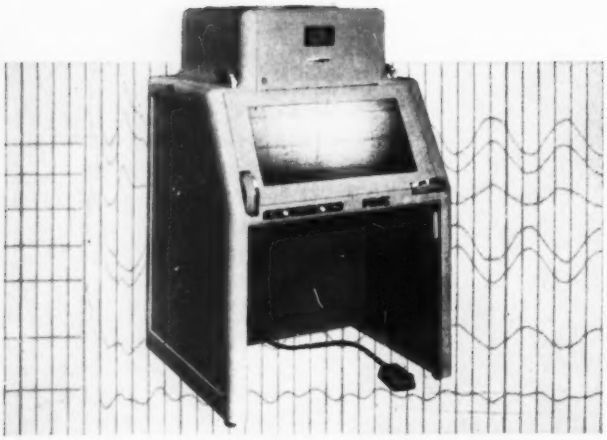

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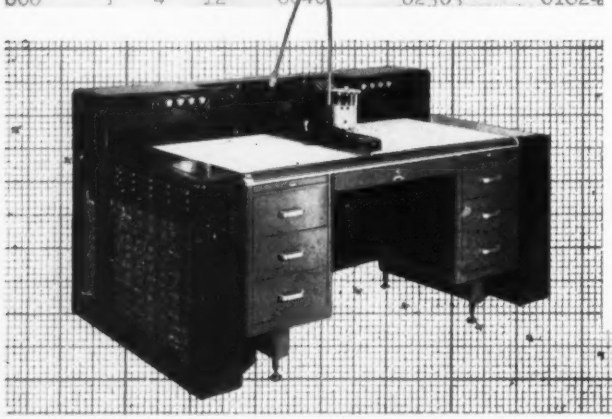

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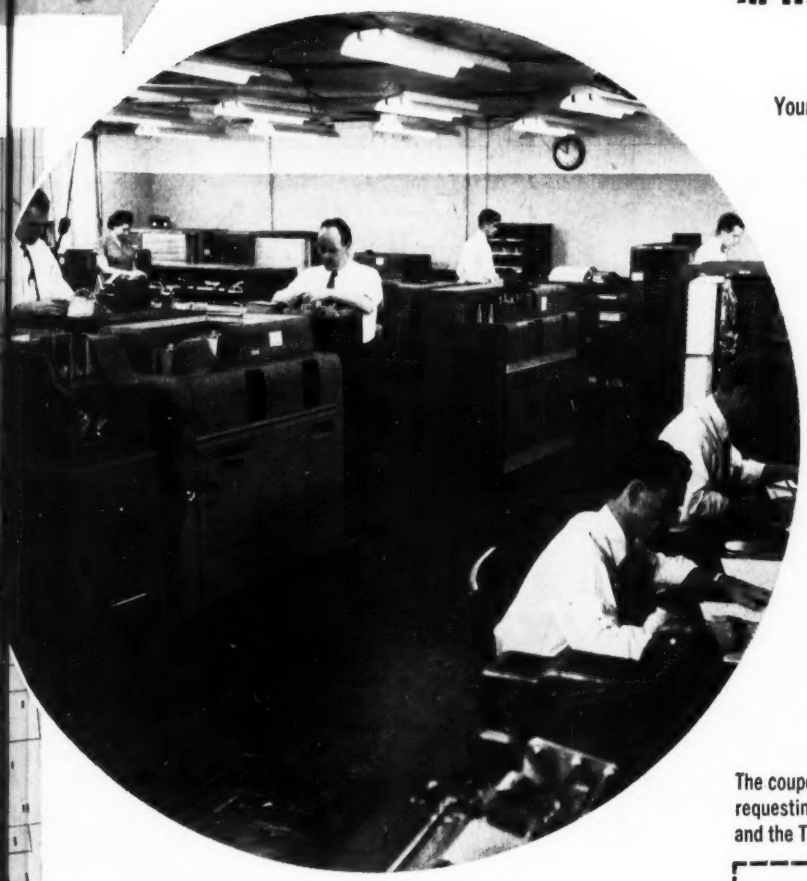
your data analysis

WAY THIS WAY



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M-2

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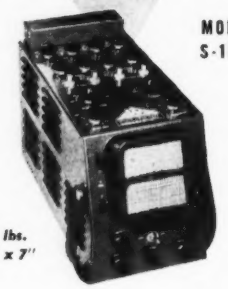

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plus—

- Greater interchangeability
- Inventories reduced 50% to 75%
- In-line, lower maintenance
- Low first cost!

* The DOMOTOR Controls Forces to 2 TONS with Hairline Accuracy—
Opens new fields of application for modern instrumentation

The Annin DOMOTOR operator offers unmatched power, stability and accuracy of valve positioning. The advantages of single seat valve construction now are made possible for applications where corrosive and erosive liquids must be accurately controlled under extremes of temperature and pressure (From—325°F to 1000°F, and to 6500 psi).

Annin DOMOTOR Valves are noted for their superior performance and their many cost-reducing features, but less known is the fact that they cost no more than ordinary valves—and often cost *less!*

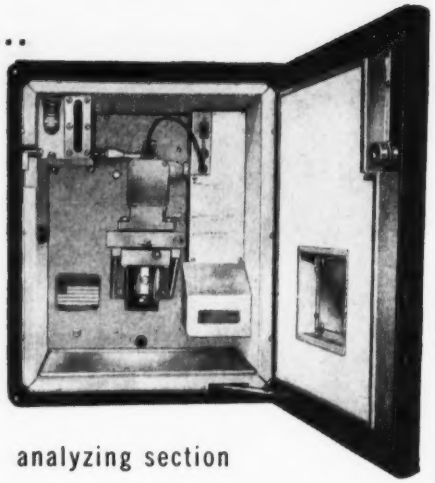
Whether you want to solve a knotty instrumentation problem, reduce operating costs, or improve performance, write and give details. Annin engineers will be glad to make a recommendation. Annin General Catalog 1500BA gives the full story. Write for it today.

ANNIN CONTROL VALVES

THE ANNIN COMPANY

for large industrial power plants and central stations...

a new CO_2 RECORDER using three established ideas



analyzing section

Designed to handle the CO_2 measurement problems of large industrial power plants and central stations the new *Hays Condu-Therm CO_2 Recorder* uses three established ideas:

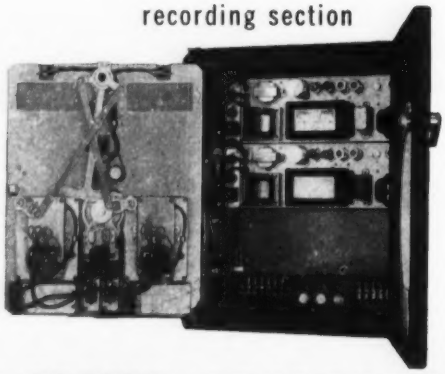
1. *The use of CO_2 measurement as a guide to combustion efficiency* . . . has been used by thousands of boiler plants and industrial furnaces, particularly where a single fuel such as natural gas, oil, bituminous or anthracite coal is being burned.

2. *The thermal conductivity principle of gas analysis* . . . has been accepted extensively in the process industries, because of its fast response to changes in gas composition, its freedom from chemicals, and its proven reliability.

3. *Electronic type operation* . . . frees the instrument of the step action and delicate construction commonly found in galvanometer operated instruments . . . also adds greater speed, power and magnification, while assuring high accuracy and permanency of calibration.

features five second response with ±.25% accuracy

recording section



the condu-therm features:

- ***5 second response to CO_2 change due to:***

  rapid change of sample gas in gas passage system

  small volume of gas in analyzing cell

  continuous connection (through amplifier) between analyzer and recording pen motor

- ***±.25% accuracy for chart ranges up to 0 to 20% due to:***

  slide wire construction . . . 5 tolerances held to .1%

  recording pen cam precision-machined to .0001 in.

  high power gain (2.5 million)

- ***"Boiler plant" construction unavailable in any other instrument:***

  linkage of ⅛" x ½" bar

  multiple pen bearing of telescoping stainless steel tubes

  oilite bearings do not require lubrication

  chart plate of ¼ in. permanent mold casting

  unit construction for easy replacement of each main element

For full information on the Hays Condu-Therm CO_2 Recorder write for Bulletin 51-1008 which includes:

detailed explanation of operation of analyzing and recording sections

completely illustrated discussion of component parts and features

drawings of and information on gas sampling systems.

THE **HAYS** CORPORATION

MICHIGAN CITY 8, INDIANA

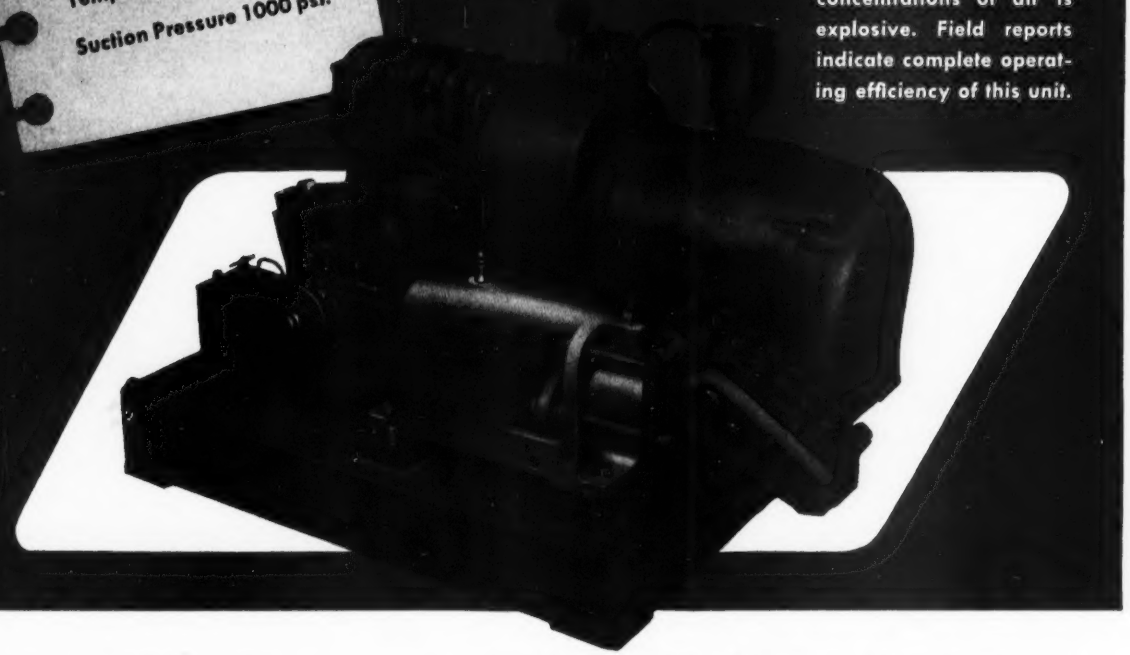
Automatic Combustion Control • Boiler Panels • Hays-Penn Flowmeters
Veriflow Meters and Veritrol • Gas Analyzers • Draft Gages
Combustion Test Sets • CO_2 Recorders • Electronic Oxygen Recorders

This is Controlled Volume Pumping

Handling liquefied gas:
pumping 8.0 gph of
compressed liquid
Ethylene at 15,000 psi.
Temperature 0° C.
Suction Pressure 1000 psi.

THIS MILTON ROY CONTROLLED VOLUME PUMP DOES THE JOB . . .

It's a Milton Roy High-Pressure Simplex, operating in the research lab of a major chemical company. Here are a few of the requirements this pump satisfies: Slow speed on the suction stroke to prevent "flashing" of the liquid Ethylene into a gas; special metallic packing which eliminates all leakage, withstands the 15,000 psi compression; refrigeration through the jacketed liquid end to maintain the Ethylene in a liquid state; explosion proof operation—liquid Ethylene mixed with prescribed percentage concentrations of air is explosive. Field reports indicate complete operating efficiency of this unit.



The successful pumping of a hydrocarbon of the peculiar and difficult nature of liquid Ethylene indicates the versatility of Milton Roy Controlled Volume Pumps. The fact that liquid Ethylene is an important building block for many organic compounds—used in anti-freezes, plastics, insecticides, resins etc.—makes high-pressure pumping of this liquid in controlled volume an industrial necessity.

And for those diversified liquids usually considered as gases at normal temperatures and pressures—carbon dioxide, Butane, Vinyl Chloride, Propane, Propylene, to mention just a few, Milton Roy Controlled Volume Pumps have pin-point application. They give flawless service.

Call the Milton Roy representative listed in your classified telephone directory for additional information on Milton Roy Controlled Volume Pumps for *your* specific process problem. Or write us direct.

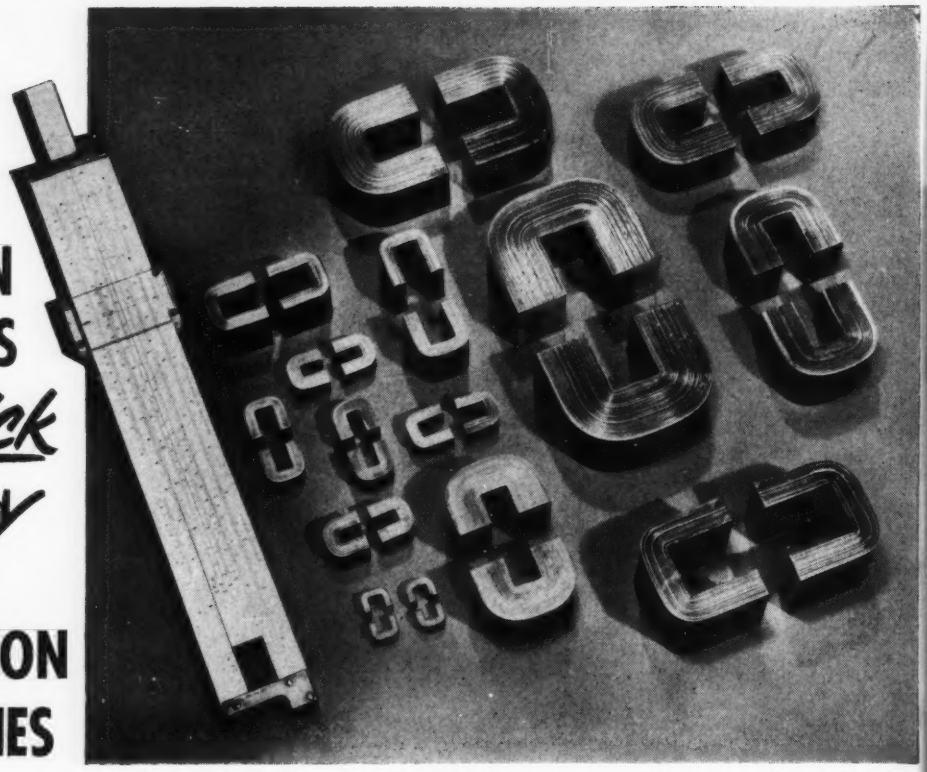
WITH THE EXCLUSIVE STEP-VALVE DESIGN

MILTON Roy COMPANY

1309 EAST MERMAID LANE, PHILADELPHIA 18, PA.

MANUFACTURERS OF CONTROLLED VOLUME PUMPS AND AUTOMATIC CHEMICAL FEED SYSTEMS

SILECTRON "C" CORES *for quick delivery* IN PRODUCTION QUANTITIES



. . . wound from strip as thin as 0.00025"

Quality-Tested and Proved

- ★ Arnold "C" Cores are made to highly exacting standards of quality and uniformity. Physical dimensions are held to close tolerances, and each core is tested as follows:
- ★ 29-gauge Silectron cut cores are tested for watt loss and excitation volt-amperes at 60 cycles, at a peak flux density of 15 kg.
- ★ 4-mil cores are tested for watt loss and excitation volt-amperes at 400 cycles, at a peak flux density of 15 kg.
- ★ 2-mil cores are tested for pulse permeability at 2 microseconds, 400 pulses per second, at a peak flux density of 10 kg.
- ★ 1-mil cores are tested for pulse permeability at 0.25 microseconds, 1000 pulses per second, at a peak flux density of 2500 gauss.
- ★ ½ and ¼-mil core tests by special arrangement with the customer.

Now available—"C" Cores made from Silectron (oriented silicon steel) thin-gauge strip to the highest standards of quality.

Arnold is now producing these cores in a full range of sizes wound from ¼, ½, 1, 2 and 4-mil strip, also 29-gauge strip, with the entire output scheduled for end use by the U. S. Government. The oriented silicon steel strip from which they are wound is made to a tolerance of plus nothing and minus mill tolerance, to assure designers and users of the lowest core losses and the highest quality in the respective gauges. Butt joints are accurately made to a high standard of precision, and careful processing of these joints eliminates short-circuiting of the laminations.

Cores with "RIBBED CONSTRUCTION"* can be supplied where desirable.

Ultra thin-gauge oriented silicon steel strip for Arnold "C" Cores is rolled in our own plant on our new micro-gauge 20-high Sendzimir cold-rolling mill. For the cores in current production, standard tests are conducted as noted in the box at left—and special electrical tests may be made to meet specific operating conditions.

• We invite your inquiries.

*Manufactured under license arrangements with Westinghouse Electric Corp.

WAD 4211

THE ARNOLD ENGINEERING COMPANY

SUBSIDIARY OF ALLEGHENY LUDLUM STEEL CORPORATION

General Office & Plant: Marengo, Illinois

engineered simplicity

capacilog STRIP CHART recorder

instantaneous "no contact" controlling

Single Point Electronic Strip Chart Recorder-Controller

gineered simplicity gives operating accuracy and chanical stamina to Capacilog Recorder-Controllers.

mination of mechanical clamping mechanism between licating pointer and control unit allows instantaneous cording action. Design simplicity confines moving parts a minimum; maintenance is easy, mechanical wear is gligible. An added convenience is the plug-in chassis facilitating quick replacement.

pacilog strip chart Recorders are available with her high or low temperature measuring systems for ctrical or pneumatic control. Write for Bulletin C2-2.

WHEELCO INSTALLATION AT LARGE MIDWESTERN UNIVERSITY

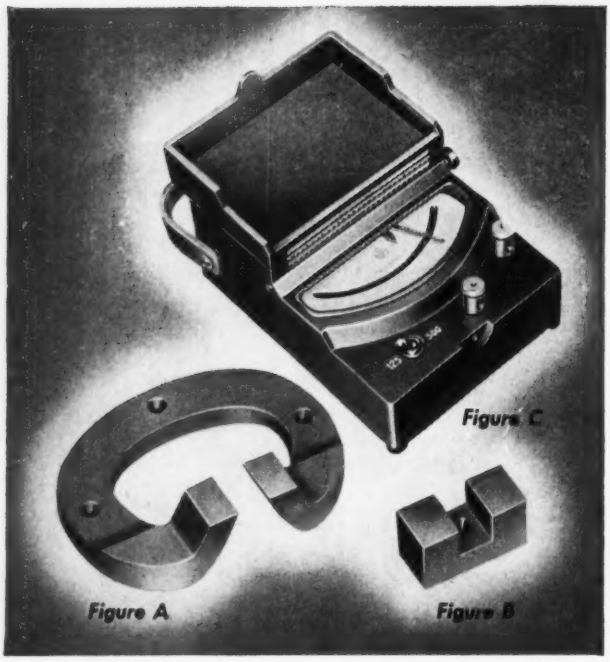
Wheelco installation in technical laboratory of prominent University, on electrically heated furnaces, for research and educational purposes. In addition to Controllers, Wheelco Capacilogs and Inputrols are used.

A Precision Product of Wheelco Instrumentality

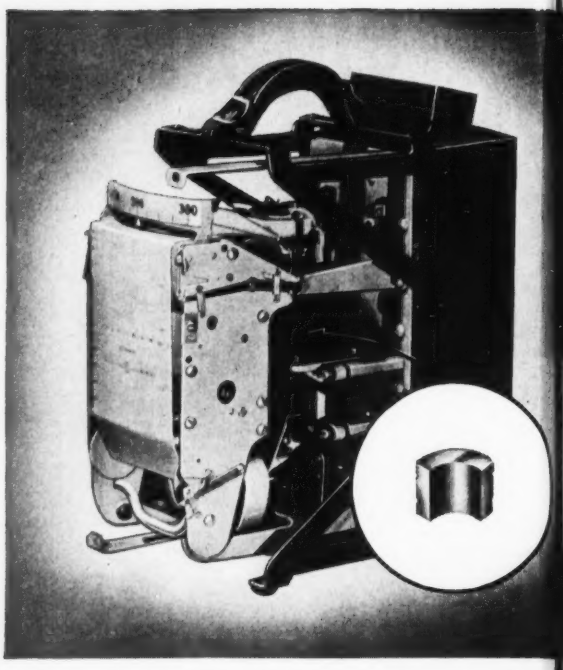
wheelco instruments division

BARBER-COLMAN COMPANY • ROCKFORD, ILLINOIS, U. S. A.

1219 ROCK STREET



INSTRUMENTS—Fig. A is damping magnet once used in GE indicators. Fig. B is tiny Carboloy magnet now used. It permits smaller indicator design (Fig. C), cuts materials and assembling costs . . . speeds up calibrations.



METERS—In this portable current recorder a Carboloy permanent magnet cuts costs by eliminating power-supplying parts. It also reduces recorder's weight by 10 pounds.

How Carboloy permanent magnets improve electrical products

CONTROLS—Switches in compact Minneapolis-Honeywell controls use permanent magnets to give safer snap action, help quench arcs. The magnets are exceptionally stable; provide uniform high energy for the life of the control.

Want to cut down product size, weight? Build a better-performing product for less money?

Then check the possibility of using Carboloy Alnico permanent magnets wherever you need *lasting* magnetic energy.

Carboloy permanent magnets are simple, self-containing sources of energy that *never* fail. They are powerful in small sizes. Need no outside power supply, no maintenance. They help reduce fabrication costs by eliminating wires, coils and operating parts. Above all, they let you simplify design . . . build a lighter, more compact, finer-performing product at a saving.

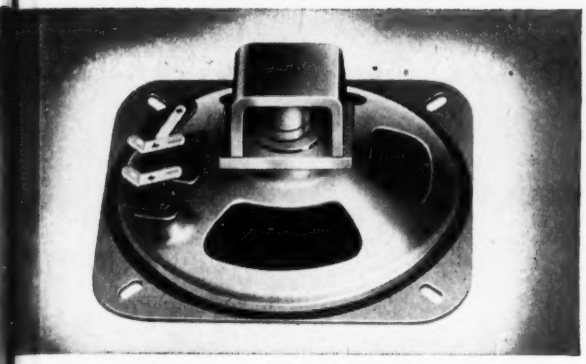
On these pages you'll see how others got the jump on competitors by using permanent magnets. Perhaps you'll get an application idea from reading about them.

CARBOLOY SERVICES

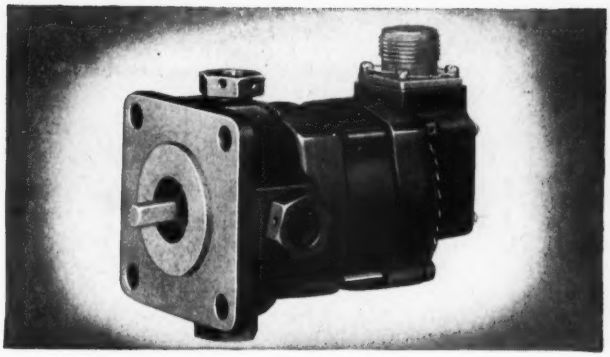
If so, check Carboloy magnet engineers for free, expert advice and an assist in design and application. Look to Carboloy production lines, too, for the uniform, high-energy Alnico magnets you'll need for best results — all sizes, all shapes; cast or sintered to your specifications.

Send coupon for free Magnet Design Manual PM-101 and Standard Stock Catalog PM-100.

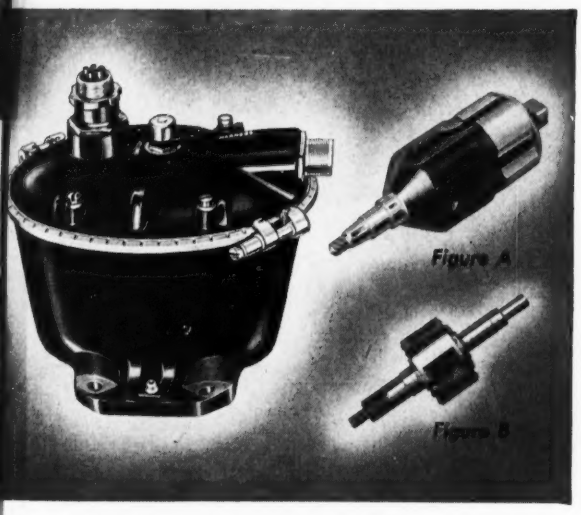
CARBOLOY
DEPARTMENT OF GENERAL ELECTRIC COMPANY
11155 East 8 Mile Ave., Detroit 32, Michigan



SPEAKERS—In speakers, permanent magnets replace larger electromagnets in field structure. Current passing through Alnico's *uniform* field makes voice coil and cone vibrate in proportion to voltage; tone is truer.



GENERATORS—When GE engineers had only 6" x 6" area for jet's tachometer generator, they whipped design problem with a tiny permanent magnet. It eliminated coils and wires, supplied the powerful energy required.



MAGNETOS—To Scintilla Magneto Division, Bendix Aviation Corp., weight savings are vital in their aircraft products. Fig. A shows chrome rotor weighing approximately 4 lbs. 9 ozs. Fig. B shows newer model rotor using Carboloy Alnico. It weighs only 2 lbs. 4 ozs.

ADVANTAGES OF CARBOLOY PERMANENT MAGNETS

1. Simple — no operating parts
2. Uniformly powerful
3. Permanent source of energy
4. No coils to wire
5. Cool-running
6. No operating costs
7. No power failures
8. Combine electrical and mechanical features
9. Simplify mechanical assemblies
10. Uninterrupted operation
11. Moisture-resistant
12. Create savings

"Carboloy" is the trademark for the products of Carboloy Department of General Electric Company

Plants at Detroit, Michigan; Edmore, Michigan; and Schenectady, New York

CARBOLOY ALNICO PERMANENT MAGNETS

Mail Coupon Today

Carboloy Department of General Electric Company
11155 East 8 Mile Ave., Detroit 32, Michigan

Gentlemen:

Please rush me, without cost or obligation, copies of Permanent Magnet Design Manual PM-101 and Standard Stock Catalog PM-100.

NAME_____

POSITION_____

COMPANY NAME_____

ADDRESS_____

CITY_____ ZONE____ STATE_____

You change ranges this simple way

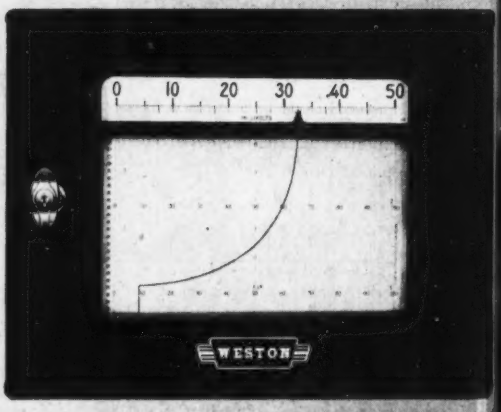
New! simplified...

Recording Potentiometer by WESTON

The question probably occurs to you, as it has to many other instrument users who have examined the new WESTON Recording Potentiometer, "Why haven't such improvements been offered before?"

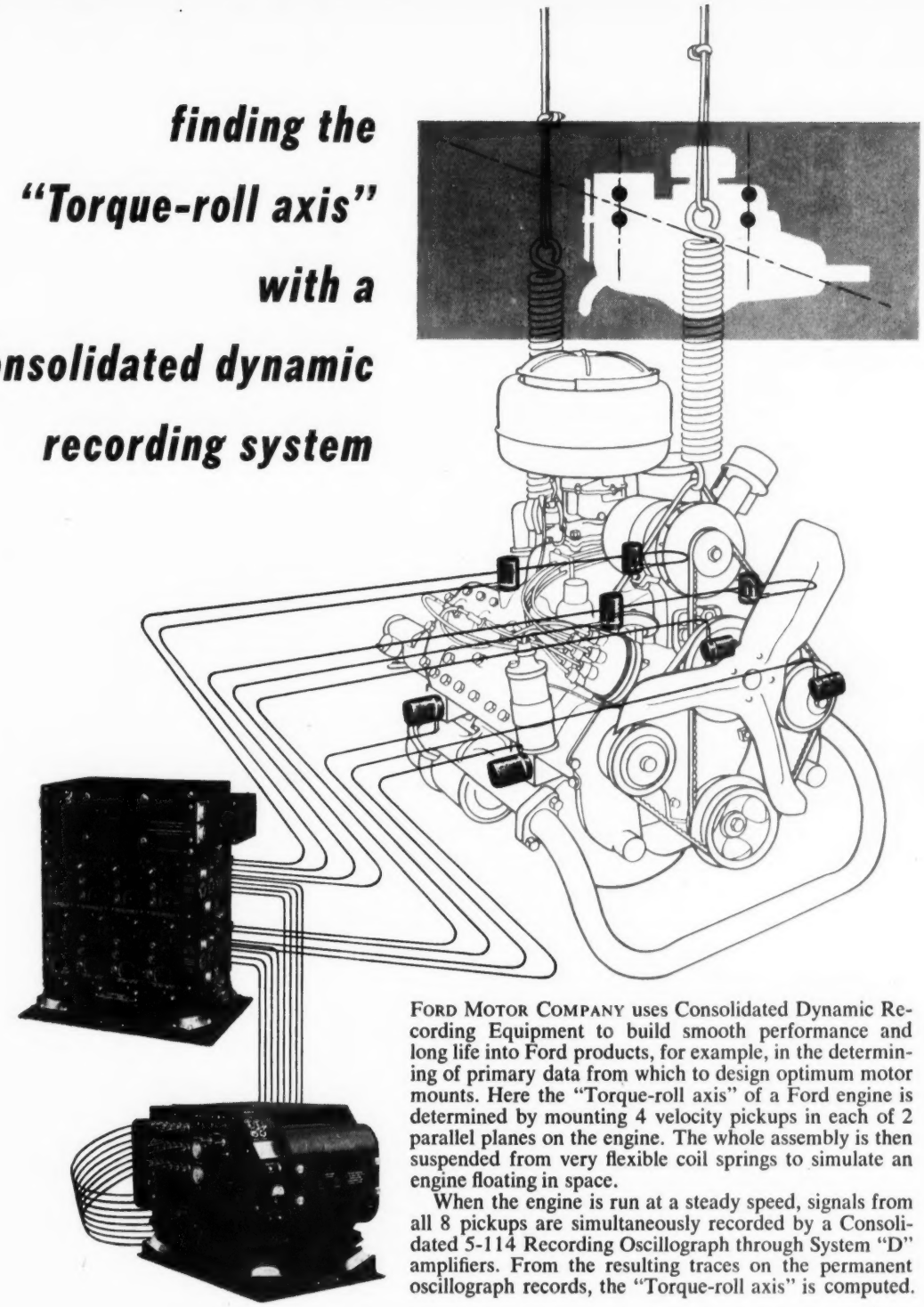
Take range changing, just as an example. *You* make the change, simply by inserting the desired range standard, as illustrated above. Not even a soldered connection to break. No change in the universal slide-wire necessary. And reference junction compensation is changed in like manner, when changing type of sensing element.

And there are many more features, electrical and mechanical, that remove the complexities from instrument operations and maintenance. They're all found in this new WESTON Recorder. Ask us to send you all the facts . . . WESTON Electrical Instrument Corporation, 617 Frelinghuysen Avenue, Newark 5, New Jersey . . . *manufacturers of Weston and Tag Instruments.*



WESTON TAG **WESTON** *Instruments* . . . INDICATE — RECORD — CONTROL

finding the "Torque-roll axis" with a Consolidated dynamic recording system



FORD MOTOR COMPANY uses Consolidated Dynamic Recording Equipment to build smooth performance and long life into Ford products, for example, in the determining of primary data from which to design optimum motor mounts. Here the "Torque-roll axis" of a Ford engine is determined by mounting 4 velocity pickups in each of 2 parallel planes on the engine. The whole assembly is then suspended from very flexible coil springs to simulate an engine floating in space.

When the engine is run at a steady speed, signals from all 8 pickups are simultaneously recorded by a Consolidated 5-114 Recording Oscillograph through System "D" amplifiers. From the resulting traces on the permanent oscillograph records, the "Torque-roll axis" is computed.

Consolidated Engineering

CORPORATION

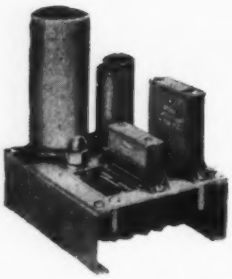
300 North Sierra Madre Villa, Pasadena 15, California

Sales and Service through **CEC INSTRUMENTS, INC.,** *a subsidiary with offices in: Pasadena, New York, Chicago, Washington D.C., Philadelphia, Dayton.*

analytical instruments for science and industry

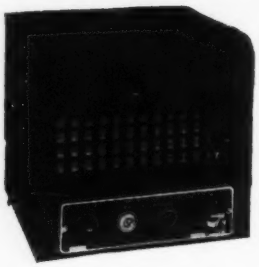
Dynamic Recording Systems

such as the one shown here have infinite variations in application and in the arrangement of the equipment. A typical recording system includes pickups, amplifiers, and a recording oscillograph. Write for Bulletin CEC 1500B.



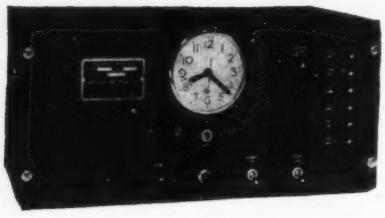
TYPE 2001-2, BASIC UNIT

Frequencies 200 to 2500 cycles. Dividers and Multipliers available for lower and higher frequencies. Miniaturized and JAN construction. Output, 6 volts.



TYPE 2005, UTILITY UNIT

Consists of Type 2001-2 and booster to provide 10 watts at 110V at precision frequencies from 50 to 500 cycles at input power frequencies of 50 to 500 cycles, 45 watts.

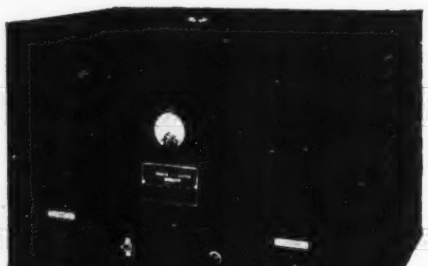


TYPE 2121-A, LAB. STANDARD

Outputs, 60 cycle, 0-110 Volts, 10 Watts; 120-240 cycle impulses. Input, 50-400 cycles, 45 Watts.

Precision FREQUENCIES

GUARANTEED ACCURATE TO 1 PART IN 100,000 (.001%)



TYPE 2111, POWER UNIT

50 Watt output. 0-110-220V at 60 cycles, or any frequency 50 to 1000 cycles. Input, 50-100 cycles. 275 watts.

THE basis of these frequency standards is an electronic fork which is temperature-compensated and hermetically sealed against humidity and barometric pressure.

Type 2001-2 and similar units are available independently. Complete instruments of our manufacture are used extensively by industry and the armed forces where unvarying, dependable high precision is required, such as for bombsights and fire control.

WIDELY USED IN SUCH FIELDS AS:

Aviation
Astronomy
Ballistics
High-Speed Photography
Viscosity Measurement
Nuclear Physics
Telemetering
Radiation Counting
Fluid Flow
Chemical Reaction
Navigation
School Laboratories
Industrial Research Labs.
Accurate Speed Control

WHATEVER YOUR FREQUENCY PROBLEMS. OUR ENGINEERS ARE READY TO COOPERATE. PLEASE REQUEST DETAILS BY TYPE NUMBER.

American Time Products, Inc.

580 Fifth Avenue OPERATING UNDER PATENTS OF WESTERN ELECTRIC COMPANY ***New York 19, N. Y.***

News

In Metering Gas, Versatile SK Rotameters Permit Quick, Accurate Flow Adjustment

(On-The-Job Photos Courtesy of Metropolitan Utilities District, Omaha, Nebraska)

SK Rotameters permit quick, accurate adjustment of flows, resulting in better operation.

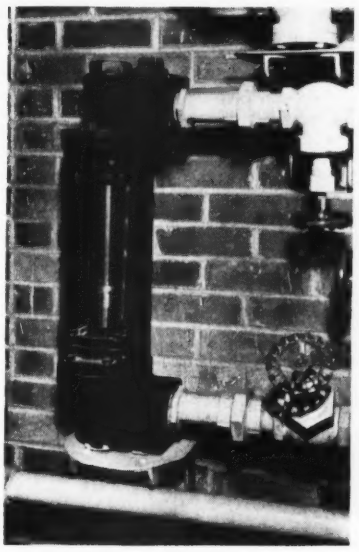
That's why Metropolitan Utilities District, Omaha, Neb. has been using them since 1935. At this plant, SK Universal Rotameters measure the flow of 1000 BTU 0.68 Sp. Gr. natural gas. Gas flow from 500 to 5000 cfh is measured at an operating pressure varying from 10 to 25 psig.

Wherever dependable metering of fluid rate of flow is required, SK Rotameters can be used advantageously because:

(1) They have long scales, clearly marked for accurate reading; (2) they have only one moving part, the rotor, resulting in a minimum of maintenance; (3) they may be disassembled and cleaned without disturbing pipe connections; (4) rigid frame construction absorbs pipe stresses and protects metering tube; (5) they can be adapted for a host of different piping arrangements and a wide range of applications.

For most metering applications, the SK Universal Rotameter is used. To meet exacting, specialized requirements, however, SK has developed and manufactures many other types of Rotameters. These include: Armored, Bypass, Chemical, Electronic Recording, Flow Alarm, Laboratory, Pneumatic Recording and others.

Although varying widely in design and construction, all types of SK Rotameters are based on the same simple principles of operation. The metered fluid passes through the Rotameter from bottom to top. The force exerted by the fluid lifts the rotor in the tapered meter tube. This force is proportional to the rate of flow and holds the rotor in a steady position for any rate of flow within the range of the meter. The rate of flow is indicated by the rotor position and readings are readily and accurately taken from the scale etched on the meter tube.



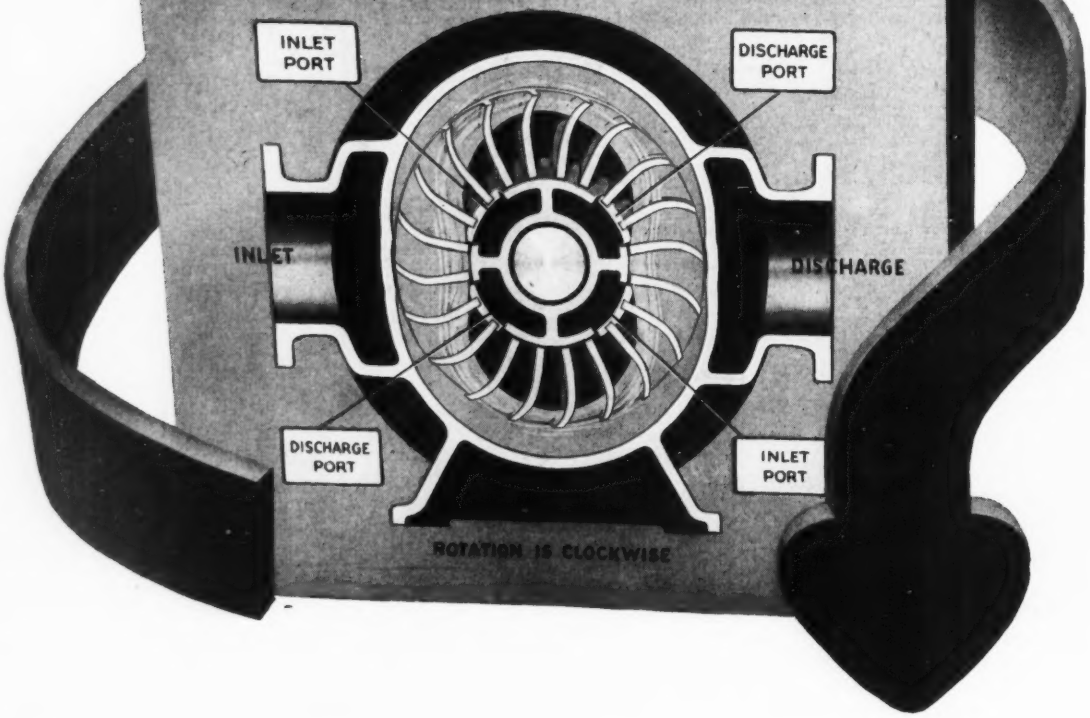
This photo of an SK Universal Rotameter at Metropolitan Utilities District, Omaha, Nebraska shows the etched, easy-to-read scale.

Detailed Bulletins are available on all types of SK Rotameters. Bulletin 18-RA, which contains general information on Rotameters, pictures and briefly describes all types and lists the number of the specific bulletin relating to each. We shall be glad to send you a free copy on request.

Quick, accurate flow adjustment is no problem for SK Rotameters.

COUTTE and ROETTING Company
Manufacturing Engineers

Nash Instrument Air Compressors deliver only clean air, free from oil or dust, and without filters



Here is Why!

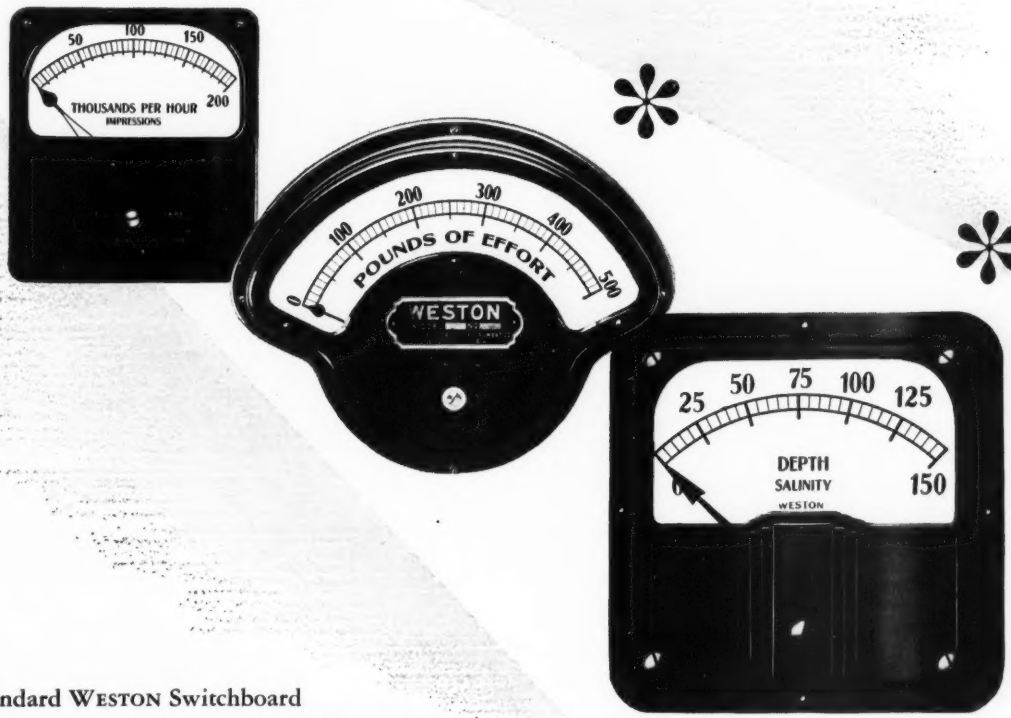
You can dispense with oil filters and dust filters when you install ®Nash® Clean Air Compressors. You can save the cost of maintaining these devices. You can greatly reduce instrument maintenance costs. For the Nash employs no internal lubrication, therefore no troublesome oil is in the delivered air. Moreover, air from a Nash is thoroughly washed and cooled as it passes thru the pump. Dust in the plant atmosphere, even fly ash, is immediately removed.

®Nash® Clean Air Compressors are simple, with only one moving element. No valves, gears, pistons, sliding vanes, or other enemies of long life and constant performance complicate a Nash. No aftercoolers are needed. You will find it profitable to investigate these pumps, now.

- No oil filters.
- No dust filters.
- No internal lubrication to contaminate air handled.
- No internal wearing parts.
- No valves, pistons, or vanes.
- Non-pulsating pressure.
- Original performance constant over a long pump life.
- Low maintenance cost.

NASH ENGINEERING COMPANY
370 WILSON, SO. NORWALK, CONN.

*NOT Catalogued!

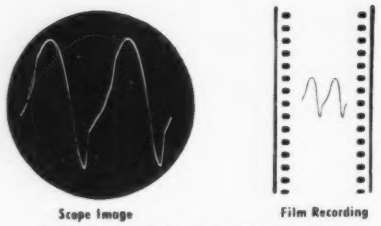


Standard WESTON Switchboard Instruments are all catalogued, of course. But these are *special* switchboard instruments . . . a few of the many hundreds of different types being constantly engineered and produced to meet specific requirements. Requirements such as . . . *special sensitivities —scale markings—pointer styles and response—mirror scales—adjustment to give maximum accuracy at critical points, etc.* Whatever your instrument requirement . . . *standard or special* . . . the answer is available here at *instrument headquarters.* WESTON Electrical Instrument Corporation, 617 Frelinghuysen Avenue, Newark 5, New Jersey . . . manufacturers of Weston and TAG instruments.

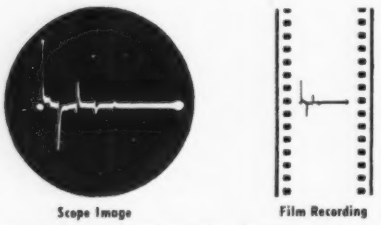
WESTON
798

SWITCHBOARD *Instruments*

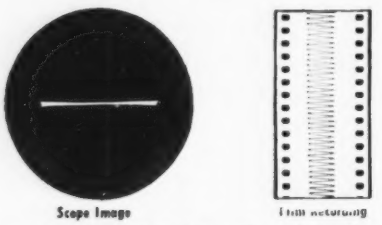
Want an oscilloscope camera NOW?



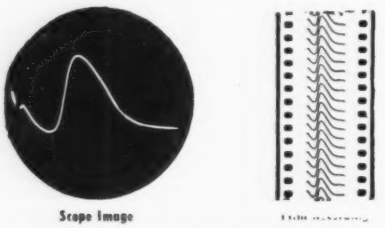
1. Single-frame photography of stationary patterns using a continuously running sweep.



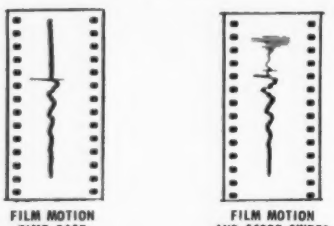
2. Single-frame photography of single transients using a single sweep.



3. Continuous-motion photography employing film motion as a time base.



4. Continuous-motion photography employing oscilloscope sweep as a time base.



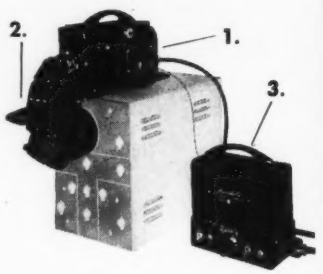
5. Continuous-motion photography employing combination of film motion and oscilloscope sweep as a time base.

Fairchild Oscillo-Record Cameras are now available *from stock* for immediate shipment. With these units you can make *permanent* photographic records of oscilloscope traces, thereby eliminating possible errors in making hand sketches from memory. In time-saving and convenience alone, these cameras will pay for themselves many times over.

FAIRCHILD OSCILLO-RECORD CAMERA IS UNUSUALLY VERSATILE

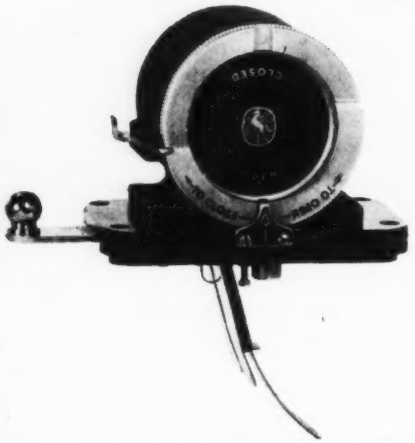
Users of the Fairchild Oscillo-Record Camera like its versatility. Designed for both still and continuous-motion photography on 35-mm film, it records non-recurring phenomena that are too rapid for visual study, others that are so slow that continuity is lost, and the occasions where very high-speed transients are combined with very slow-speed phenomena. For some idea of the types of jobs this instrument can do, study the examples at the left. Each solves a particular problem. Oscillo-Record camera users especially like its:

- **CONTINUOUSLY VARIABLE SPEED CONTROL**—1 in/min. to 3600 in/min.
- **TOP OF SCOPE MOUNTING** that leaves controls easily accessible.
- **PROVISION FOR 3 FILM LENGTHS**—100, 400 or 1,000 feet.



1. Camera, 2. periscope, 3. electronic speed control. Accessories include 400- and 1,000-ft. film magazines, magazine adaptor and motor, universal mount for camera and periscope, binocular split-beam viewer.

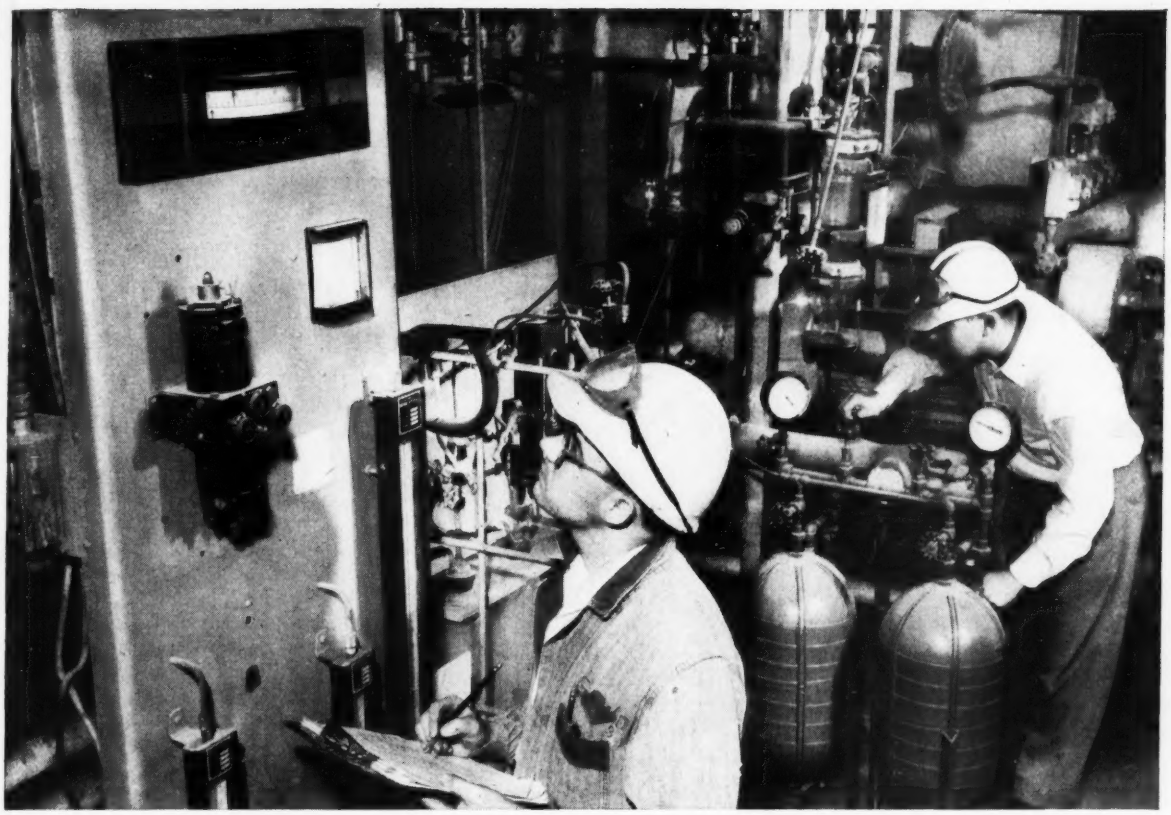
FAIRCHILD TAKE-UP CASSETTE FOR SHORT RUNS



Where only a few pictures are required for quick development and study, a small Take-up Cassette is available as an accessory. The convenience afforded by this unit results in the saving of considerable time in handling short runs and reduces film wastage to a minimum. It is easily attached to the top of the camera by means of an adapter. A built-in knife permits short lengths of exposed film (up to 10 feet) to be cut off and removed with the cassette for developing.

Complete information about applications and operation of both the Fairchild Oscillo-Record Camera and the Fairchild-Polaroid Oscilloscope Camera is available. Write today to *Fairchild Camera and Instrument Corporation, 88-06 Van Wyck Boulevard, Jamaica 1, New York, Department*

FAIRCHILD
OSCILLOSCOPE RECORDING CAMERAS



CHEMICAL PLANT HCL FUMES HAVE HAD NO EFFECT ON THIS PYROMETER'S ACCURACY; ABOVE, OPERATOR TAKES PYROMETER READING

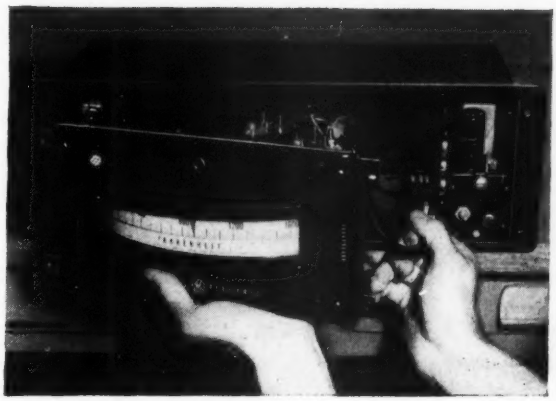
"Extremely Corrosive Atmosphere— No Change in G-E Pyrometer Accuracy"

The calibrated accuracy of General Electric pyrometers is within ¾ of 1 per cent of full scale. And these instruments are built to take excessive punishment. A large eastern chemical manufacturer writes: "We use the HP-3 pyrometer to control the temperature of heat transfer oil. The surrounding atmosphere is extremely corrosive, due to hydrochloric acid fumes—yet there has been no sign of operational difficulty or failure."

CLOSE TEMPERATURE CONTROL. Any change in temperature, even as small as 0.1% full scale, starts immediate control action. All pyrometer models are available in a variety of temperature ranges in the 0-3000 F span.

HIGH FLUX DENSITY is provided by a 3¼-pound alnico magnet. It also allows large air gaps. The lightweight moving system effectively resists shocks and vibration.

FOR MORE INFORMATION, call your G-E representative or write for Bulletin GEC-713. General Electric also offers a complete line of thermocouples—described in GEC-714. Write Section 602–238, General Electric Company, Schenectady, New York.



FOUR TYPES AVAILABLE—indicating, protecting, two- and three-position control forms. Both flush and surface mountings can be supplied; wide variety of temperature ranges is available.

GENERAL ELECTRIC

You've got a Winning Combination

A STANDARD ISA FACE-TO-FACE DIMENSIONS
K "FLOW LINE" CONTOURED BODY
Q STELLITED SEATING SURFACES
J RENEWABLE SEAT
10 SEAT RINGS EASILY REPLACED WITH VALVE IN PIPE LINE

with the New

TRADE **LESLIE** MARK

DOUBLE SEATED DIAPHRAGM CONTROL VALVES

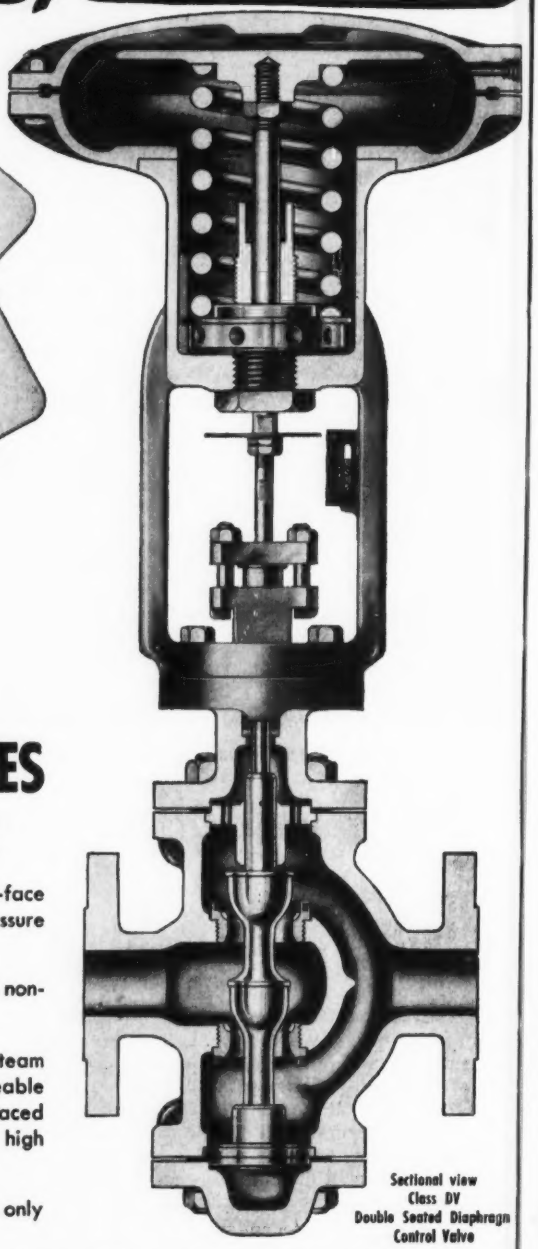
Calling a spade a spade you've got a "royal flush" of features in these new Valves designed for use with control instruments.

Their "Flow-Line" Contoured Bodies have ISA standard face-to-face dimensions and high capacity, low turbulence and minimum body pressure drop characteristics.

A new type, top and bottom guided construction is self-aligning and non-binding regardless of uneveness of bolt tightening.

Standard, integral stellited seating surfaces are recommended for steam service to reduce seat ring thread corrosion. Renewable, interchangeable seat rings also furnished where desired and may be easily replaced without removing valve body from the line. Elaborate grinding at high temperatures is completely eliminated.

With these Valves, you get as *standard equipment*, features heretofore only obtainable in expensive, specially designed valves.



Sectional view
Class DV
Double Seated Diaphragm
Control Valve

Look for LESLIE REGULATORS under "Valves" or "Regulators" in your classified telephone directory in the following cities where LESLIE factory trained engineers are located:

Albany, N. Y.	Chicago, Ill.	Galveston, Tex.	Memphis, Tenn.	Orlando, Fla.	Salt Lake City, Utah
Albuquerque, N. M.	Cincinnati, Ohio	Greenville, S. C.	Miami Springs, Fla.	Philadelphia, Pa.	San Francisco, Calif.
Atlanta, Ga.	Cleveland, Ohio	Houston, Texas	Milwaukee, Wis.	Pittsburgh, Pa.	Seattle, Wash.
Baltimore, Md.	Dallas, Texas	Indianapolis, Ind.	Minneapolis, Minn.	Ponca City, Okla.	St. Louis, Mo.
Beaumont, Tex.	Denver, Colo.	Kansas City, Mo.	Mobile, Ala.	Providence, R. I.	Syracuse, N. Y.
Birmingham, Ala.	Des Moines, Ia.	Kingsport, Tenn.	Monroe, La.	Richmond, Va.	Tucson, Ariz.
Boston, Mass.	Detroit, Mich.	Los Angeles, Calif.	New Orleans, La.	Rochester, N. Y.	Wilkes-Barre, Pa.
Bridgeport, Conn.	El Paso, Tex.	Louisville, Ky.	New York, N. Y.	Rutherford, N. J.	Wilmington, Calif.
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***WRITE FOR* Bulletin 513**

ESTABLISHED 1900
LESLIE CO.

1707

FLOATLESS LEVEL CONTROLS • PRESSURE REDUCING VALVES • PRESSURE CONTROLLERS
SELF CLEANING STRAINERS • PUMP GOVERNORS • TEMPERATURE REGULATORS
• AIR HORNS • STEAM WHISTLES

Announcing the new bulletin describing the HAGAN

DIFFERENTIAL TRANSMITTER

(TYPE FRB RING BALANCE)

The Hagan Type FRB Differential Transmitter produces pneumatic output signals which are linear with the pressure differential measured.

This transmitter can be used for generating output signal pressure under the wide range of differential and static pressure conditions, for both liquids and gases, common to the process industries, metallurgical furnace and steam plants.

Bulletin 3M-52 tells you about the Hagan Type FRB Differential Transmitter and what it does. It is yours for the asking.

HAGAN CORPORATION

RING BALANCE FLOW AND PRESSURE INSTRUMENTS
THRUSTORQ FORCE MEASURING DEVICES
BOILER COMBUSTION CONTROL SYSTEMS
METALLURGICAL FURNACE CONTROL SYSTEMS

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Hagan Building
Pittsburgh 30, Pennsylvania

Please send me a copy of the new bulletin on the Hagan Differential Transmitter.

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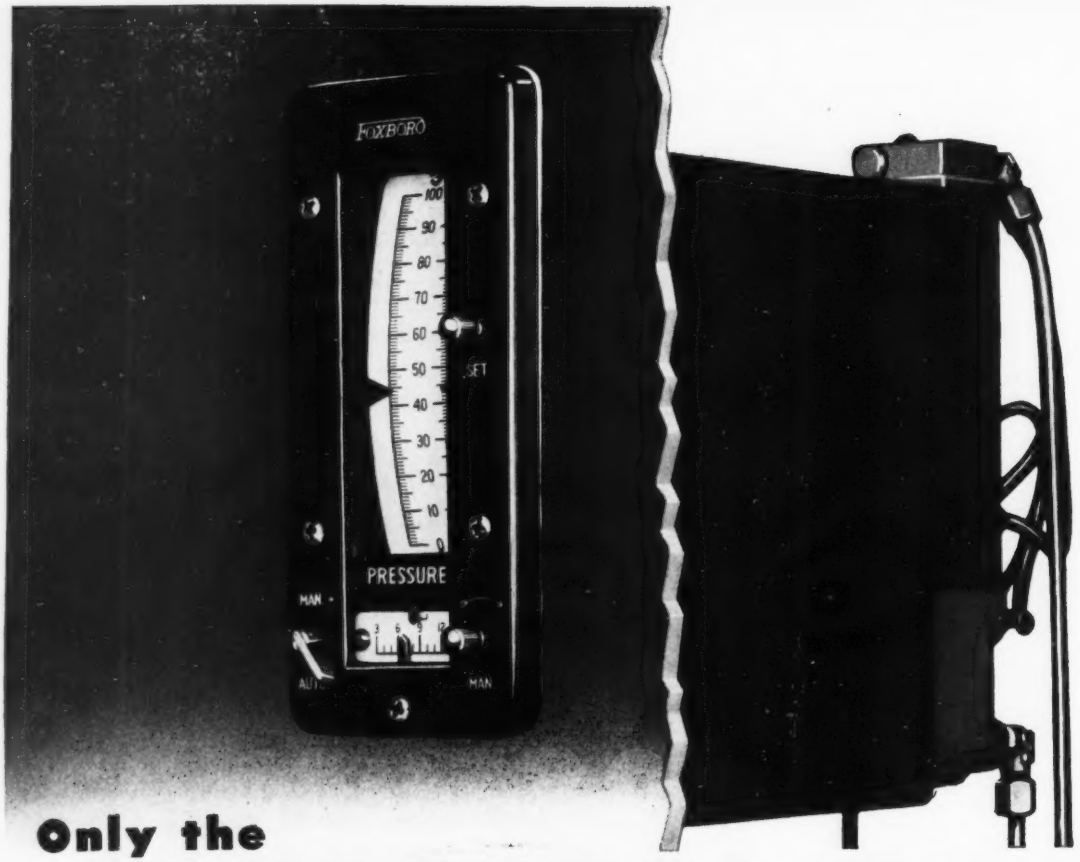
I-10



Only the CONSOTROL M/52

gives you all these advantages!

For indicating control functions in your console or graphic panel instrumentation, no other controller offers so much for so little money as the Foxboro Consotrol M/52 Indicating Controller. Compare these combined advantages:

1. **A completely self-contained, compact, panel-mounted Indicating Receiver Controller** that costs up to 20% less, installed, than usual graphic panel indicating control.
2. **Simple installation** — only 2 connections besides the air supply.
3. **Pull-out feature** that provides complete accessibility of control mechanism from front of panel.
4. **Instrument-type pressure transmitter for driftless** remote manual control, instead of usual pressure regulator.
5. **Simple 2-position transfer switch** and "foolproof" transfer indicator provide absolutely bumpless transfer.
6. **Graphic panel compactness** — takes only 3 5/16" x 7 5/16" of panel space.
7. **"Full-size" performance** — control action unsurpassed by the finest conventional-size controllers. Available in Proportional, Proportional with Reset, Proportional with Derivative, Proportional with Reset and Derivative, and On-Off.
8. May be used with separately-mounted recorder using conventional circular charts. Up to 6 records may be combined on one chart with the Foxboro Multi-Record Recorder. (Consotrol Recorder-Controllers, featuring full scale 4" strip charts, also available.)

Get full details of this space-saving, cost-saving instrumentation. Write for Bulletin 463 describing the complete Consotrol Line of graphic panel instruments. **The Foxboro Company, 4610 Neponset Ave., Foxboro, Mass., U. S. A.**

FOXBORO
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RECORDING · CONTROLLING · INDICATING
INSTRUMENTS

STAYNEW

ABSORPTION FILTERS PROVIDE

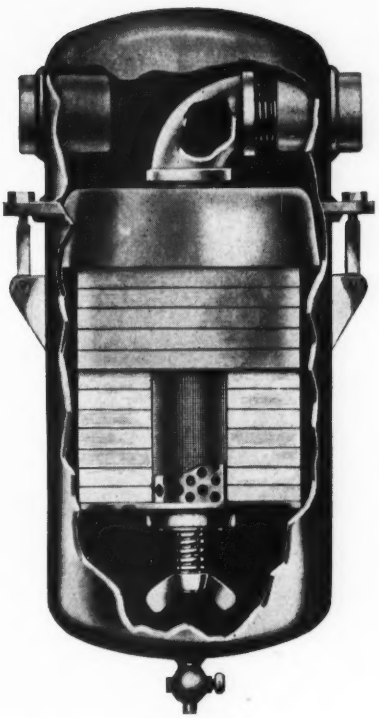
SUPER FILTRATION!

—REMOVE LAST TRACES OF OIL AND MOISTURE FROM COMPRESSED AIR LINES

The model AAPH Absorption Type Filter has proven itself to be the real answer to the elimination of costly service interruptions in utility and industrial power plants. Many manufacturing processes and certain compressed air operated equipment require the removal of condensed oil and water vapors *completely* from the compressed air. In thousands of installations all over the country, Staynew Absorption Filters remove the last traces of oil and moisture and prevent failure of combustion and other pneumatic controls . . . keep maintenance time and cost at a minimum.

For Complete Information, Write Today For Bulletin B-1A

Representatives in Principal Cities



MODEL AAPH
Absorption Filter

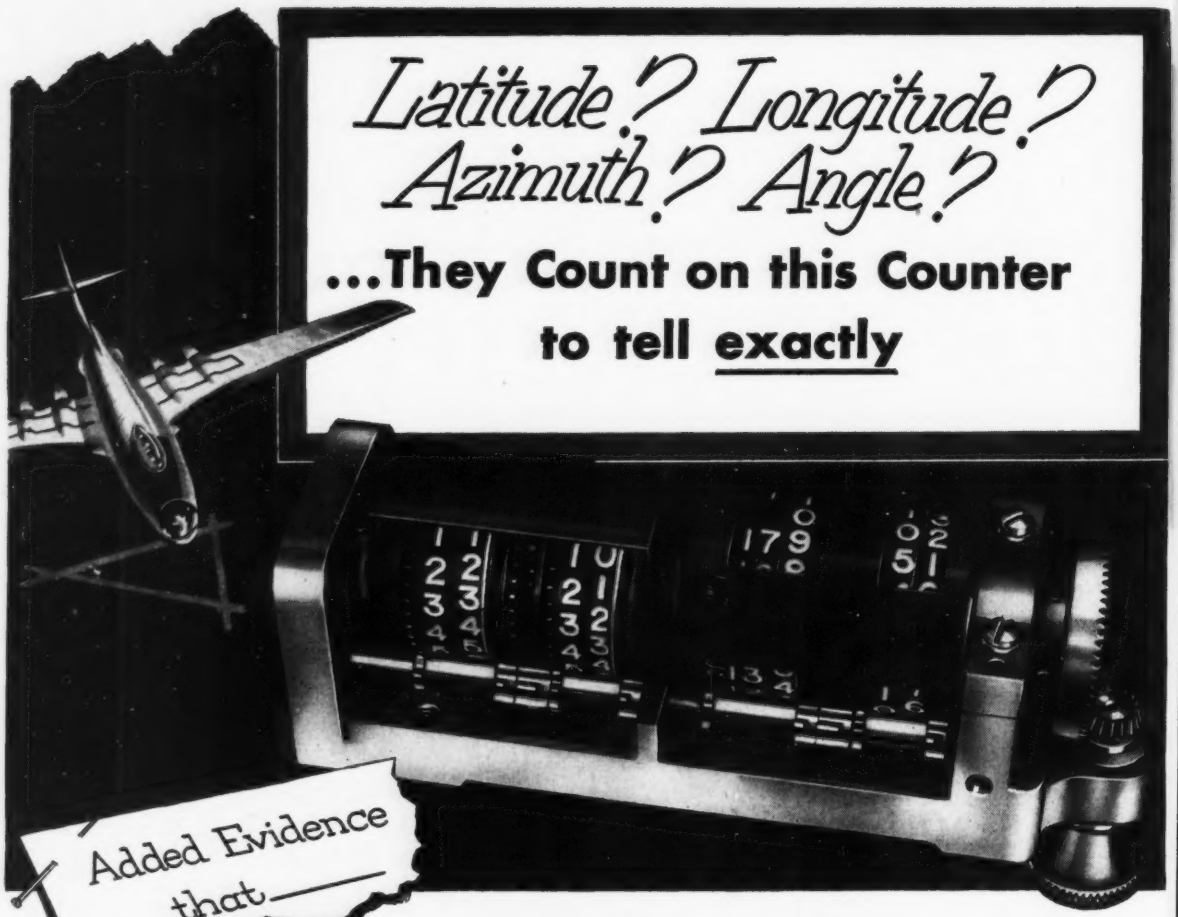
DOLLINGER
REG. PROTECTOMOTOR U.S. PAT. OFF.
STAYNEW FILTERS

DOLLINGER

CORPORATION

63 Centre Pk., Rochester 3, N. Y.

ALL TYPES OF FILTERS FOR EVERY INDUSTRIAL NEED



Added Evidence that——

Everyone Can Count on VEEDER-ROOT

Aerial navigators and bombardiers rely on the figures that keep turning up on this Veeder-Root Counter, specially designed for the Armed Forces. And if *you* need to know exactly where you are, with any product or mechanism that's vital to Defense, then you can count on Veeder-Root to help you, to the utmost limits of ability . . . and of available capacity. Write:

VEEDER-ROOT INCORPORATED
"The Name That Counts"
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"Counts Everything on Earth"

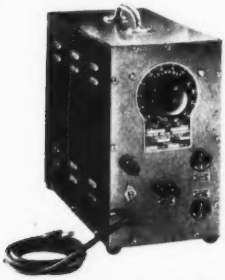
THE SOLA FAMILY OF

5 Voltage Regulator Types

MEETS MOST MILITARY and INDUSTRIAL REQUIREMENTS

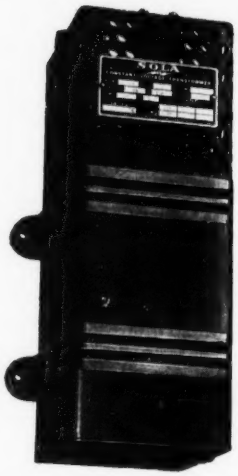
SOLA adjustable, harmonic filtered type CVL:

Regulation ±1%
Harmonic Distortion less than 3%
Output adjustable from 0-130 volts



SOLA standard type CV:

Regulation ±1%



SOLA television receiver type CVA:

Regulation ±3%
Plug-in accessory unit

SOLA plate and filament type CVE:

Regulation ±3%

SOLA harmonic filtered type CVH:

Regulation ±1%
Harmonic Distortion less than 3%

CHARACTERISTICS OF SOLA CONSTANT VOLTAGE TRANSFORMERS

- Static-magnetic regulation
- Ultra-fast response (1.5 cycles)
- No moving or renewable parts
- No manual adjustments
- Complete automatic, continuous regulation
- Self-protecting against short circuits
- Automatic current limiting action
- Choice of transformation ratios

We invite you to write regarding your voltage regulating problems, or for inclusion of your name on our technical mailing list.

SOLA *Constant Voltage* TRANSFORMERS

Made under one or more of the following patents: 2,143,745; 2,212,198; 2,346,621; 2,552,111; 2,489,245 and patents pending.

Transformers for: Constant Voltage • Fluorescent Lighting • Cold Cathode Lighting • Airport Lighting • Series Lighting • Luminous Tube Signs Oil Burner Ignition • X-Ray • Power • Controls • Signal Systems • etc. • SOLA ELECTRIC CO., 4633 W. 16th Street, Chicago 50, Illinois

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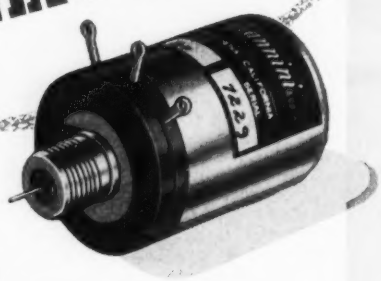
AVAILABLE FOR IMMEDIATE DELIVERY!



MICROTORQUE* POTENTIOMETER

You are now assured immediate delivery of the Microtorque* Potentiometer. As a new service to customers, a complete stock of resistance values as listed, is maintained to assure immediate delivery for prototypes, experimental work or emergency production. The Microtorque* is the solution where remote indicating, low torque (.003 oz. in.), jewel bearings and instrument quality are required.

Other Giannini Potentiometers that are available on special order; soon to be stocked.

SPECIFICATIONS

LINEARITY: ± 0.5% of total resistance.

MAXIMUM OPERATING SPEED: 100 rpm.

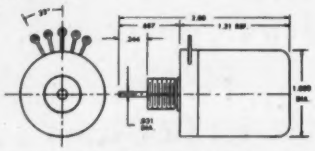
ACCELERATION: Will withstand 50G steady state acceleration in best axis.

VIBRATION: Will withstand 0.06" double amplitude sinusoidal vibration from 10 to 55 cps in best axis.

AMBIENT TEMPERATURE: Will function mechanically from −54° C. to + 71° C.

MOMENT OF INERTIA: 2 x 10−⁴oz-in.² (approx.)

TEMPERATURE COEFFICIENT OF RESISTANCE: .0006/° C. Max.



Following Microtorques* are available from stock in quantities of six or less:

RES. OHMS	STARTING TORQUE IN-OZ.	TURNS OF WIRE TYPE 2	TYPE 9	CURRENT** MA.	PRICE***
250	.006	350	450	57	$45.00
1,000	.004	500	650	28	$40.00
2,000	.004	700	750	20	$40.00
5,000	.003	900	1200	14	$40.00
10,000	.003	1,000	1300	10	$40.00
25,000	.003	1,000	1300	7	$45.00

**Must be de-rated for ambient temperature over 60° C

***Prices apply to quantities of six or less. For quotation on larger quantities or special types, please write

Above Microtorques* are available in the following two types
Type 2: 270° ± 10° Electrical Rotation, Mechanical Rotation Limited by internal stops

Type 9: 354° Min. Electrical Rotation, Mechanical Rotation Continuous Brush does not short ends of coil

Giannini also produces potentiometers of various types, including non-linear functions, and tapped windings

Synchromount

Linear and functional outputs. Ball bearings; ¼" shaft. 0.1 oz. in. torque. 500 to 100,000 ohms. 1.125" diameter x 1.16" long.

Rectipot

Straight-line motion along axis. Linear or functional outputs. 200 to 60,000 ohms. 5 sizes, 1" diameter from 2.33 to 6.54" long.

Synchromount JUNIOR

Linear and functional outputs. .078 shaft — miniature ball bearings. ⅞" diameter x 1" long. .01 oz. in. torque. 500 to 100,000 ohms.

Foremost manufacturer of toroidally-wound potentiometers. Where linearity, stability, rigidity, power dissipation and precision are required, toroid windings are outstanding performers.

*MICROTORQUE—*T.M. REG. 1952

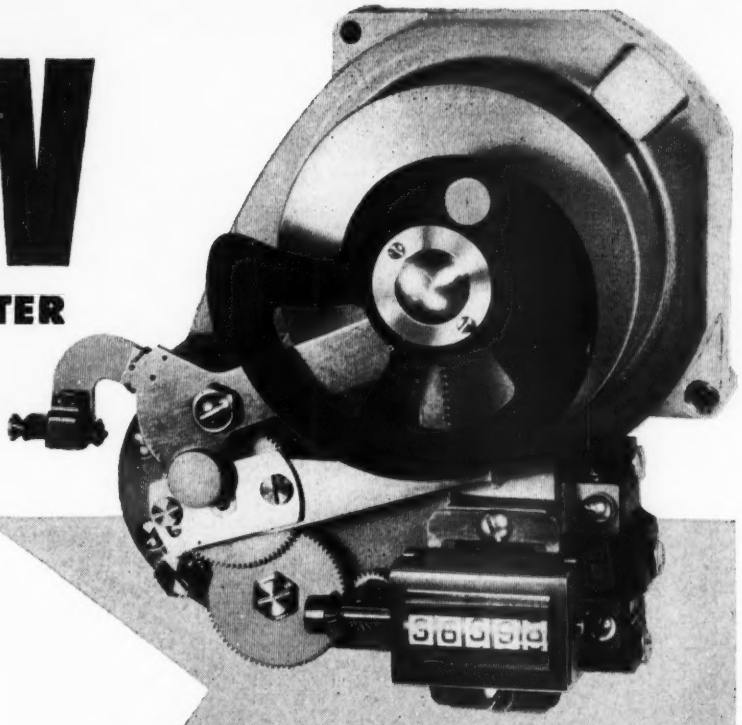
Giannini

INSTRUMENT QUALITY
POTENTIOMETERS

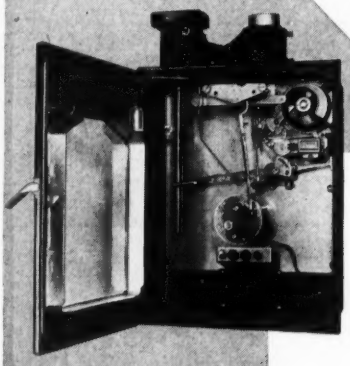
G. M. GIANNINI & CO., INC. PASADENA 1, CALIF. EAST ORANGE, NEW JERSEY

new

FISCHER & PORTER FLOW RATE INTEGRATOR



New . . . and providing a degree of precision never before approached — *plus* Fischer & Porter adherence to quality of design and components . . . the new 1600 Series Integrator merits your careful analysis.



Measure these outstanding benefits:

1. High speed—only 2½ seconds between counts. Follows rapid fluctuations in input signal with highest fidelity.
2. Motor drive — GE type SMY, low speed synchronous motor — absolutely unique in this field.
3. Standard or explosion proof available from stock.
4. Completely enclosed mechanism—new die-cast aluminum case built to meet unusual dust tight, vapor tight, waterproof or explosion proof requirements.
5. All mechanisms completely enclosed, permanently lubricated.
6. Mechanical accumulator — unique F & P design of an infinitely variable roller clutch and reverse brake mechanism, magnetically loaded eliminating springs and friction. Entire mechanism oil immersed for permanent cleanliness, lubrication, and freedom from wear and corrosion.
7. Motor drive gears and overtravel crank enclosed and permanently lubricated with silicone instrument grease.
8. New counter — clearly visible — no peep holes.
   — available with predetermining counters for limiting process quantities.
   — available with reset, remote electric repeater counters.
9. Input cams available for linear, square root or fractional power flow or other functions.

Complete information on the new Series 1600 Integrator is yours for the asking.

FLOWRATOR

FISCHER & PORTER COMPANY

1400 COUNTY LINE ROAD, HATBORO, PENNA.

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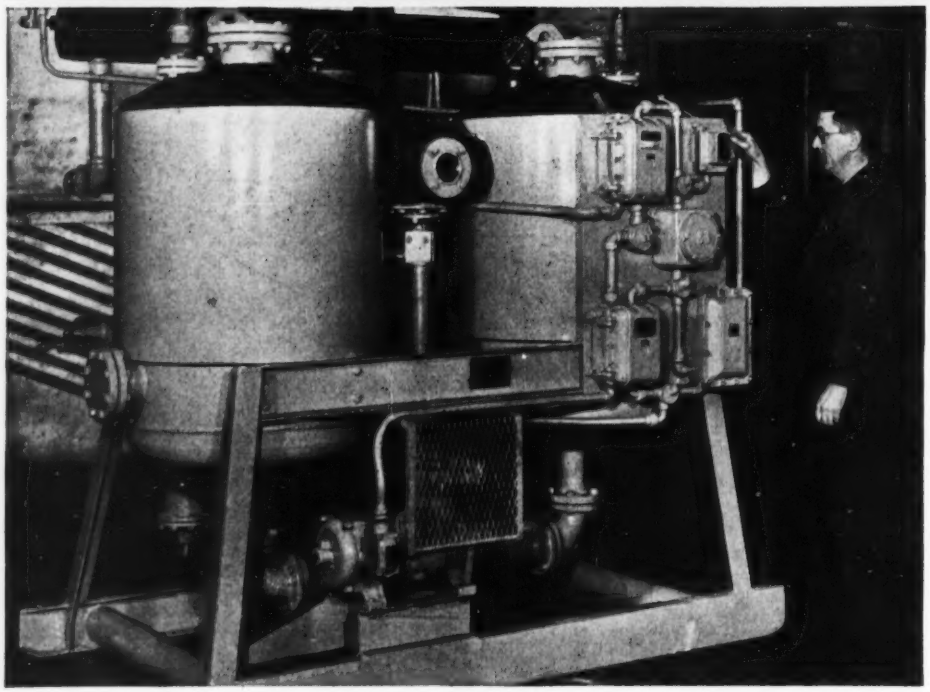
for minimum DRYer investment
choose the new Lectrodryer model "BY"



Built to A. S. M. E. code. Operates on pressures up to 150 p.s.i.g. Higher pressure models optional. Wide range of capacities—to 30,000 standard c. f. m.

We stepped up the tempo for this new model "BY" Lectrodryer* to enable you to DRY air with a minimum investment in equipment.

By speeding up the DRYing cycle (reversing the DRYing-regenerating cycle oftener) the new Lectrodryer can operate with less activated alumina. This means that the "BY" Lectrodryer itself can be smaller, and hence cost less. Besides, it has only one moving part—the valve reversing mechanism. Its operation is completely automatic.

This Lectrodryer is new—but old enough to have been thoroughly tested in customers' plants.

We'll be glad to tell you more about how the new Lectrodryer model "BY" can help control your WETth problems at substantial savings in original equipment investment. Just write Pittsburgh Lectrodryer Corporation, 330 32nd Street, Pittsburgh 30, Pennsylvania.

QUICK SPECS
ON THE NEW "BY" LECTRODRYER

Fully automatic
Lower first cost
Low operating cost
Simple—
only one moving assembly
Steam or electrically reactivated
Compact

In England: Birlec, Limited, Tyburn Road, Erdington, Birmingham.
In Australia: Birlec, Limited, 51 Parramatta Road, Glebe, Sydney.
In France: Stein et Roubaix, 24 Rue Erlanger, Paris XVI.
In Belgium: S. A. Belge Stein et Roubaix, 320 Rue du Moulin, Brossoux-Liege.

LECTRODRYERS DRY
WITH ACTIVATED ALUMINAS

LECTRODRYER
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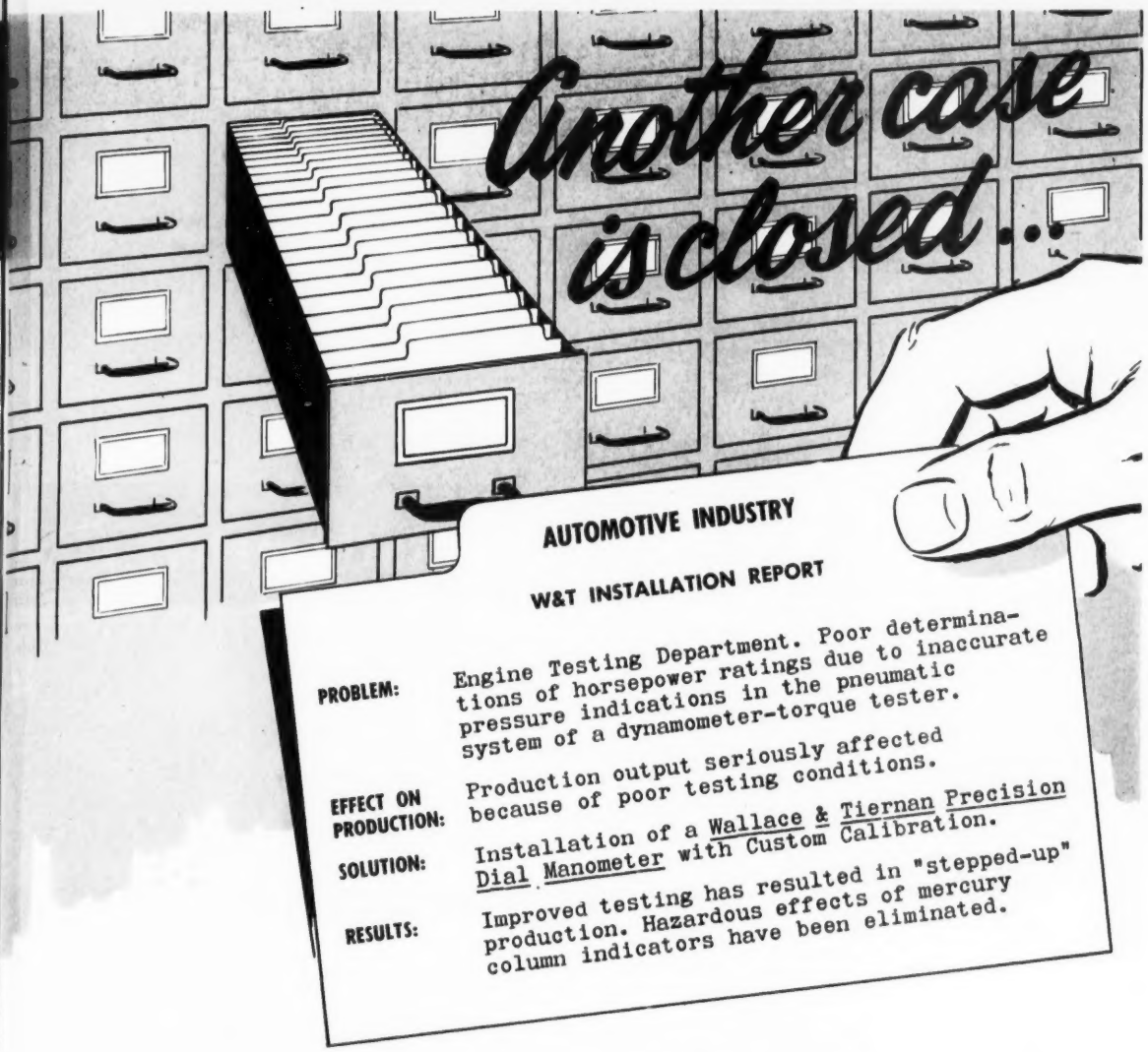
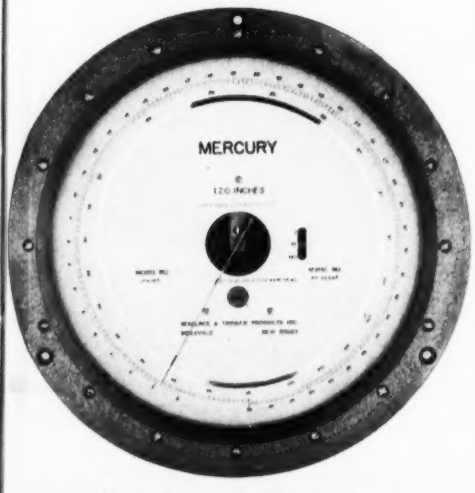

Another case is closed...
AUTOMOTIVE INDUSTRY
W&T INSTALLATION REPORT
PROBLEM: Engine Testing Department. Poor determinations of horsepower ratings due to inaccurate pressure indications in the pneumatic system of a dynamometer-torque tester.
EFFECT ON PRODUCTION: Production output seriously affected because of poor testing conditions.
SOLUTION: Installation of a Wallace & Tiernan Precision Dial Manometer with Custom Calibration.
RESULTS: Improved testing has resulted in "stepped-up" production. Hazardous effects of mercury column indicators have been eliminated.

...Thanks to a W&T Precision Instrument



W&T Precision Dial Manometer

FEATURES:

Full protection against overpressure
Custom calibrated scales in units of force or torque
Two revolution indicator provides scale 45 in. long with only an 8½ in. diameter dial.
Sensitivity one part in 10,000; accuracy one part in 1000.
If you have a problem in the measurement or control of pressure, write today for additional information.

WALLACE & TIERNAN
PRODUCTS, INC.
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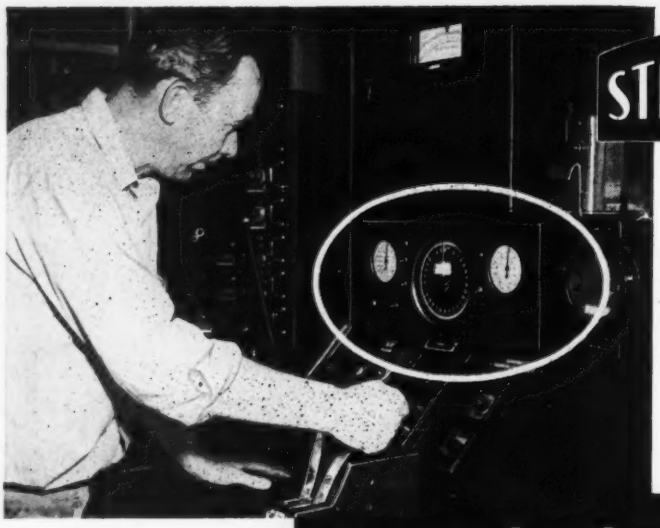


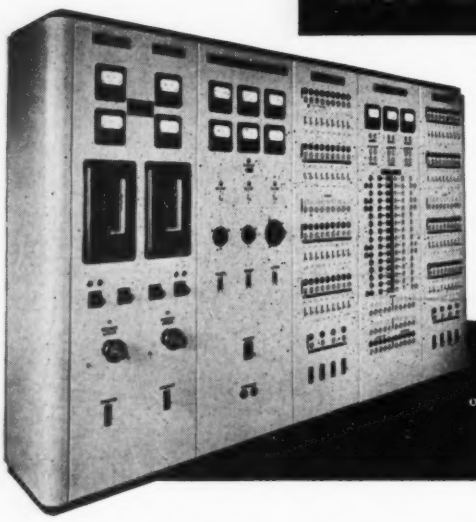
STANDARD

SINCE 1884

WRIGHT AERONAUTICAL DIVISION
CURTISS-WRIGHT CORPORATION

This photograph, taken in one of the experimental cells of the Wright Aeronautical plant at Woodridge, N. J., shows a STANDARD Chronotachometer installed in their test panel.

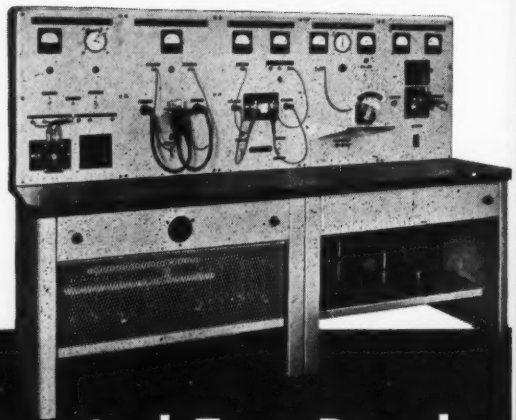
Not Only Chronotachometers . . .



WILSON DAM (T. V. A.)

This experimental control and distribution switchboard handles various power supplies for their Chemical Laboratory Building.

plus "flexlab" Control and Distribution Switchboards



WESTINGHOUSE ELECTRIC COMPANY

This specially designed unit is for the control and test of aircraft timers, series relays, contactors, servo motors, and booster coils. It is typical of the wide range of custom-built equipment by STANDARD.

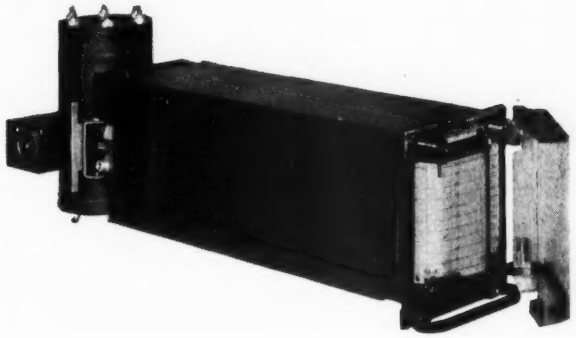
. . . but all kinds of Custom-built Electrical Test Panels

THE STANDARD ELECTRIC TIME COMPANY

93 LOGAN STREET · SPRINGFIELD 2, MASSACHUSETTS

PLUG IN

THE NEW IDEA IN PANEL INSTRUMENTATION



Taylor, pioneer in the 3-part control system, brings many new refinements based on extensive field experience

1. **Change** from simplest to most complex control by simply unplugging one unit, plugging in another.

2. **Change** from indicator to recorder or vice versa in only 10 seconds.

3. **One mounting** for both controller and receiver—recorder or indicator.

4. **Recorders or indicators** can be mounted on the panel without welding, without drilling holes.

5. **Only piping connections** required are air supply, controller output, and to variable transmitter. All other connections made automatically in self-sealing manifold.

6. **All adjustments** can be reached without disturbing any connections.

7. **Mountings** are extremely simple and rugged.

8. **You save panel space** by mounting units a few inches apart.

9. **Receiver mechanism** totally enclosed by protective sleeve.

10. **You save money** on installation—thanks to simplified piping and mounting.

ADDITIONAL NEW FEATURES IN TAYLOR'S TRANSET® RECORDER:

Continuous valve position indication on separate scale tells valve pressure at a glance.

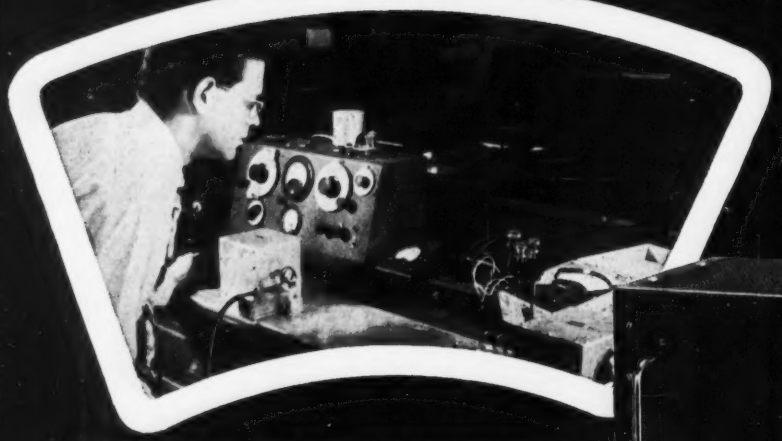
Chart read-back device gives easy access to past records without disturbing any function of the recorder or interrupting the record.

New chart drive mechanism for greater convenience and greater dependability.

Be sure to get information on the new and greater plug-in type Taylor TRANSET Control before you make any decision involving pneumatic transmission control. Taylor Instrument Companies, Rochester, N.Y., and Toronto, Canada.

TAYLOR INSTRUMENTS MEAN ACCURACY FIRST

ARE YOUR READINGS TRUE?



CABINET TYPE IE5101

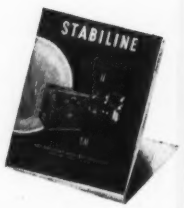
MODERN INSTRUMENTATION *Demands* STABILINE *Automatic Voltage Regulators*

RACK TYPE IE5101R

TYPE IE INSTANTANEOUS ELECTRONIC

You may have the best instrumentation in the laboratory — in shop processes —on test and inspection lines . . . you may collect the most concise data . . . but the information gathered is worthless unless it is dependably accurate. The best instruments can give true readings **only** when the source of voltage is constant.

There is no better way to maintain constant output voltage from a-c power lines than with a STABILINE Automatic Voltage Regulator type IE. This completely electronic device with no moving parts offers instantaneous correction of line voltage variation — waveform distortion not exceeding 3% — excellent stabilizatioh and regulation. Numerous types are available in a wide range of ratings to fulfill the needs of your particular requirement.



Send today for complete information on STABILINE Automatic Voltage Regulator type IE, and at the same time, ask about STABILINE type EM. **Write to:**

710 THURE AVE., BRISTOL, CONN. and ASK FOR SECO BULLETIN S351.

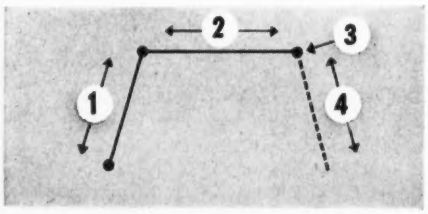
THE SUPERIOR ELECTRIC CO.
BRISTOL, CONNECTICUT

- STABILINE AUTOMATIC VOLTAGE REGULATORS
- POWERSTAT VARIABLE TRANSFORMERS
- VARICELL D-C POWER SUPPLIES
- VOLTBOX A-C POWER SUPPLIES
- SUPERIOR 5-WAY BINDING POSTS
- POWERSTAT LIGHT DIMMING EQUIPMENT

If You're Batch-Cooking You Can Use This Inexpensive Control

Here is a recorder-controller planned especially for economically controlling processes like batch cooking. The Gotham Elapsed Time Recorder-Controller does the essential control jobs easily and accurately. First of all, it brings the batch up to maximum holding temperature fast. It holds the batch at that temperature for a predetermined period. It shuts down the process at the end of the cooking period. Those are its three standard functions. Automatic venting or cooling functions can be added. Also available with a pressure, instead of temperature, system.

Write for full information about the Elapsed Time Recorder-Controller and other Gotham Controllers. They're in Catalog 500.



This Is What the Gotham Elapsed Time Recorder-Controller Does

1. Brings controlled variable (temperature or pressure) up to maximum fast.
2. Holds variable at maximum for predetermined period.
3. Shuts down process.
4. Automatic venting or cooling can be added.

Gotham Elapsed Time Recorder-Controller

SPECIFICATIONS

CHART SIZE: 12"

CASE: Standard - black crinkle; smooth black or white may be obtained.

ACTUATION: Vapor, Gas or Mercury for temperature. Pressure elements available.

CHART DRIVE: Spring wound or synchronous motor.

CONTROL SYSTEM: Pilot relay with adjustable sensitivity for 0 to 30% throttling band is standard, two position or 100% throttling band available.

HOLDING PERIOD: Standard 0 to 3 hrs. Other periods available.

Keep Everything Under Control With Gotham

GOTHAM INSTRUMENTS

Division of AMERICAN MACHINE AND METALS, INC.
Dept. 2, 233 Broadway, New York 12, New York

Here's why

it pays to know your

HSM

HONEYWELL SUPPLIES MAN

Brown charts are made of paper specifically designed for clear, dependable inking . . . precisely calibrated for accurate recording. Planned buying . . . the HSM way . . . eliminates possibilities of damage or shrinkage often caused by excessive storage time.

E. W. MORGANSTERN, Honeywell Supplies Man in the Chicago area, helps check stocks of Brown recorder charts at Sinclair Research Laboratories . . . where the HSM Plan assures wise buying and balanced inventories of all pyrometer supplies.

You'll be pleasantly surprised when you, too, learn how this plan can add new convenience and economy to your pyrometer supplies purchasing!

There's a Honeywell Supplies Man near you . . . at your local Honeywell office . . . as near to you as your phone. Call him in today . . . let him show you how the HSM plan can work in your plant.

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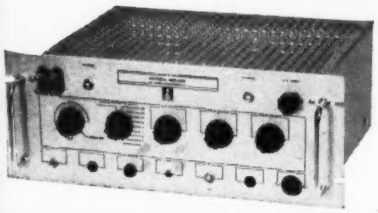
BROWN INSTRUMENTS
First in Controls

● *Important Data*

Write for new Pyrometer Supplies Buyers' Guide No. 100-4

AMPLIFIES LOW VOLTAGES

Analysis of static or dynamic conditions involving either high or very low forces is simplified with this Brush Direct-coupled Amplifier. Used with the Brush Magnetic Oscillograph, any need for complicated intermediate equipment is eliminated. The direct-coupled Amplifier has high sensitivity and low drift . . . zero signal drift not more than one chart millimeter per hour.



RACK-MOUNTED STRAIN ANALYZER

This new Brush Strain Amplifier, functionally similar to the standard table top model, is designed for mounting in a standard 19-inch rack. When used with the Brush Direct-Writing Oscillograph, the equipment records either static or dynamic strains with direction and magnitude shown on the chart. Operation is simple, records are immediately available and easily interpreted.

SHOWS SURFACE PROFILE

The Brush Surface Analyzer® shows average roughness in micro-inches, and also provides a chart of surface irregularities. The chart shows a highly magnified profile of the surface, on which varations of less than 1 micro-inch are readily apparent. Eliminates guesswork in specifying and checking finishes.

For complete information write The Brush Development Co., Dept. EE-42, 3405 Perkins Ave., Cleveland 14, Ohio

Charts instantaneously... Saves time!

● You eliminate laborious testing and plotting of data when you use Brush Recording Analyzers. Static or dynamic phenomena, electrical or mechanical in nature, can be recorded instantaneously with high accuracy.

This two-channel Brush Magnetic Oscillograph, used with the proper Brush Amplifier, makes a direct dual-chart recording of voltages, currents, or physical phenomena such as strains, pressures, accelerations, torques, forces, displacements, or vibrations. Either direct inking or electric stylus models are available.

Flexibility is a major advantage with the Brush Oscillograph. Chart speeds of 5, 25, or 125 mm. per second can be selected readily. An auxiliary chart drive for slower speeds is available. Other accessory equipment provides event markings for an accurate time base, or for correlation of events.

Apply time-saving Brush instruments to your testing problems . . . in the laboratory, on the test floor, or in the field. You'll get expert technical assistance from Brush representatives located throughout the U. S. In Canada: A. C. Wickman, Limited, Toronto.

For catalog write The Brush Development Company, Dept. A-42, 3405 Perkins Ave., Cleveland 14, Ohio

PUT IT IN WRITING WITH A BRUSH RECORDING ANALYZER

THE Brush DEVELOPMENT COMPANY

BRUSH

Piezoelectric Crystals and Ceramics
Magnetic Recording Equipment
Acoustic Devices
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Industrial & Research Instruments

REPUBLIC
INSTRUMENTS
AND CONTROLS

Do You Know About ALL of the **REPUBLIC** *Line?*

Check the Republic line of measurement and control equipment listed below. You'll find instruments and controls to meet your needs—whether for a simple control or an automatic control system. And teamed with this equipment is an experienced engineering staff which can give you the right answer to your measurement and control problems.

☐ **ELECTRICAL FLOW METERS.** For metering the flow of steam, water, gas, air, oil, brine, etc. The reading instruments, indicator, recorder and integrator, are remote reading and can be supplied singly or in any combination desired. Integration is continuous, an exclusive Republic feature.

☐ **PNEUMATIC TRANSMITTERS.** For converting process variables such as flow, liquid level, pressure, or liquid density into air pressures which vary proportionally with the process variables. These air pressures can be used as a measuring impulse for the actuation of an automatic controller or a direct reading recorder.

☐ **CO_2 METERS.** Provide a continuous record of percent CO_2 in flue gas measured by the Orsat method. Furnished with either mechanical or electrically actuated remote reading indicator and recorder.

☐ **DRAFT INSTRUMENTS.** Indicating or recording types in single or multiple units. Furnished in all standard ranges of draft and pressure.

☐ **THERMOMETERS.** A long distance, gas filled thermometer with either single or multiple pen recorder.

☐ **LIQUID LEVEL INSTRUMENTS.** Remote reading indicators and recorders. Also provided with various types of alarm devices.

☐ **MULTI-POINT INDICATORS.** Will indicate, on separate vertical scales from two to sixteen units of draft, pressure, flow, temperature, CO_2, etc., in any combination desired.

☐ **MULTIPLE RECORDERS.** Strip Chart Type will record from three to six separate records of flow, temperature, CO_2, pressure, etc., in any combination desired. Round Chart Type can have up to 4 pens.

☐ **REGULATORS.** For the automatic control of pressure, draft, rate of flow, rate of fuel feed, speed of rotation, liquid level, etc. For proportioning two pressures or flows. Regulators may be either air or oil operated. Flexibility in design and construction allows the regulator to perform any type of control action. Setting may be remote or manual.

☐ **AUXILIARY RELAYS.** Multiplying, dividing, adding, subtracting, maximum and minimum setting, ratio, ratio computing, sequential, splitter, squaring, square root extracting, and position indicating.

☐ **COMBUSTION CONTROLS.** A centralized, automatic system for controlling steam pressure, combustion, furnace pressure, excess pressure, boiler level, etc. Automatically regulates the fuel and air input to a boiler in measured proportions and in a fixed ratio for the entire load range. Adaptable to multi-fuel firing.

☐ **DESUPERHEATERS.** Atomizing type desuperheater uses a small quantity of high pressure steam to vaporize an automatically controlled amount of water in reducing steam temperature to the desired degree.

☐ **VALVES—REGULATING AND PRESSURE REDUCING.** Designed and built for all practicable ranges of pressures with either flanged or welded ends. Special body design sharply reduces erosion and noise. Cylinder operated valves available in sizes from 3 in. to 24 in. Hand operated valves in sizes from 1 in. to 8 in. Lever operated valves in sizes up to 16 in. Republic valves are built in accordance with A.S.A. Standards for all pressures up to 2500 psi. Diaphragm operated valves are available for pressures from 125 to 1500 psi and from 3 in. to 10 in. in size. Special purpose alloy steel butterfly valves in sizes 4 in. to 24 in. are also available.

Data Books are available on any of the above equipment

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There's Nothing finer for

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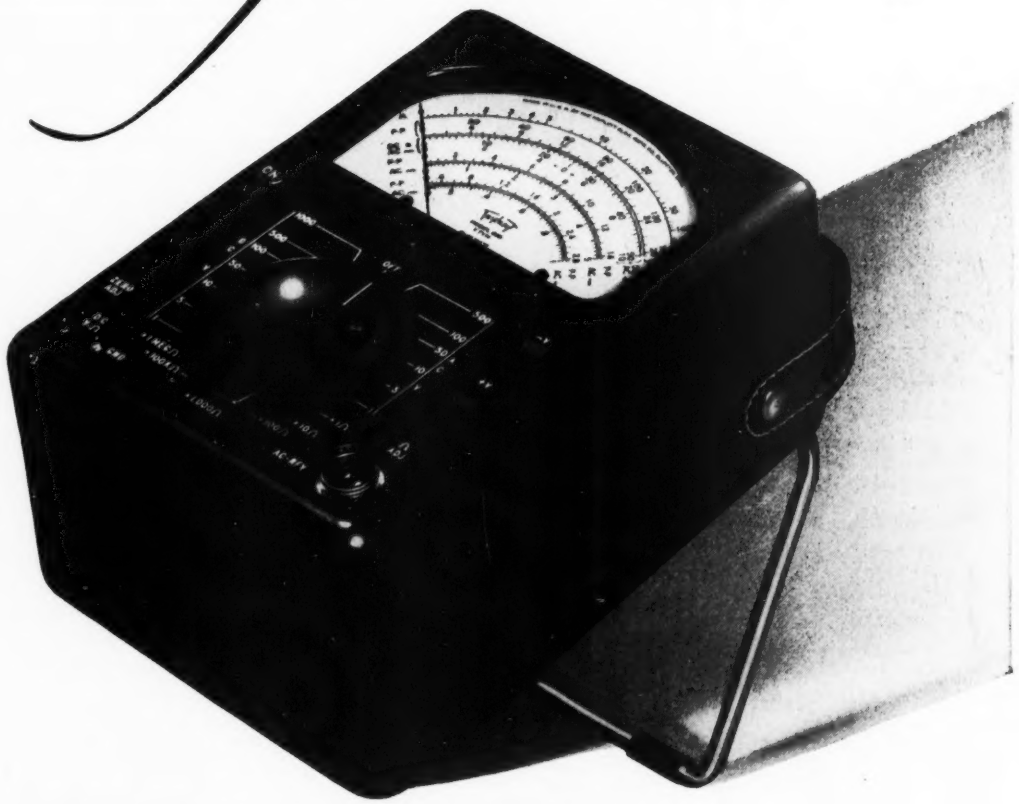

This combination of features explains why

- Complete frequency coverage with one probe, 20 cps to over 110-mc. Insulated and shielded RF tube probe, found usually only with laboratory instruments, is included.
- Peak to Peak ACV and RF with one probe.
- One volt full scale reading on AC & DC.
- One main selector switch, all ranges.
- ACrms—Peak to Peak
- 32 Ranges
- Zero center mark for FM discriminator alignment plus any other galvanometer measurements.
- High input impedance 11 megohms on DC.

Suggested U.S.A. Dealer Net $69.50 • *Prices subject to change without notice.*

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Triplett

TRIPLETT

Here's How to Erase Smoke Troubles

VIOLATION OF SMOKE ORDINANCE

LOSS OF FUEL ECONOMY

BAD COMMUNITY RELATIONS

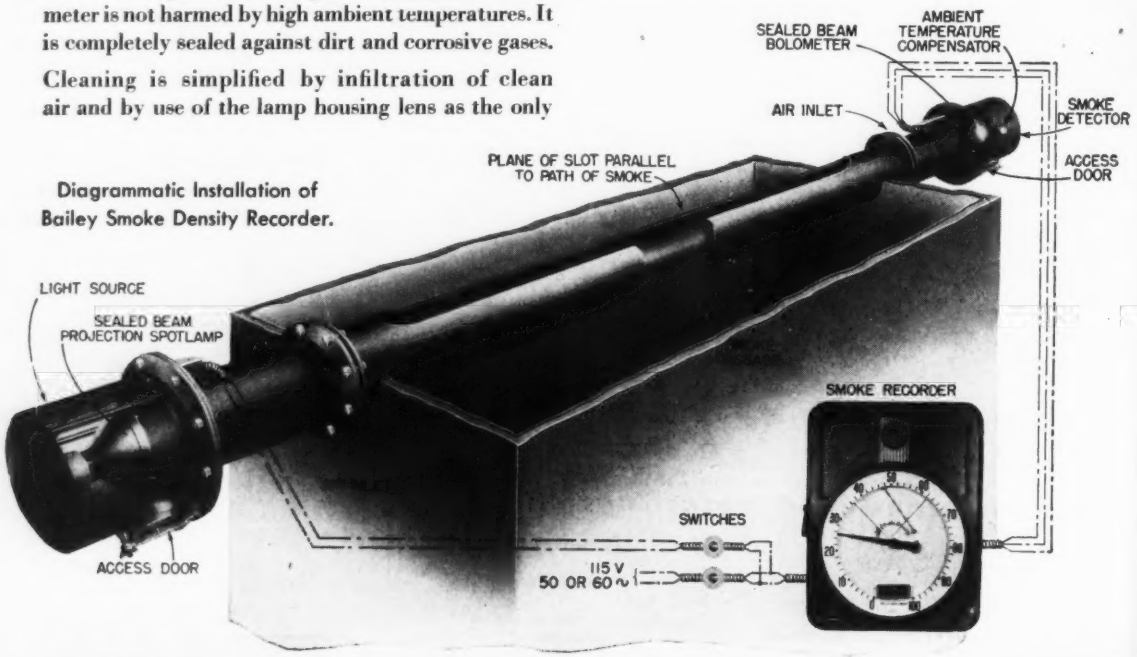
★ One of your first steps in erasing these troubles which result from excessive smoke, should be the installation of a Bailey Smoke Density Recorder. This 24-hour recorder is not an ordinary photo-cell instrument. Instead it detects smoke density by a Bolometer which is simply a sturdy tungsten filament and a parabolic mirror, mounted in a standard sealed beam automobile head lamp housing.

In using this simple, unique smoke detector, you do not have to provide cooling devices since the Bolometer is not harmed by high ambient temperatures. It is completely sealed against dirt and corrosive gases.

Cleaning is simplified by infiltration of clean air and by use of the lamp housing lens as the only window between the Bolometer and the gas passage.

It's easy to secure and maintain alignment of the sealed beam light source with the Bolometer since they are mounted at opposite ends of a slotted pipe which extends across the smoke passage.

For complete information on how you can profitably use this unique instrument to erase your smoke troubles, ask for Bulletin 211, "Bailey Smoke Density Recorder".



Diagrammatic Installation of Bailey Smoke Density Recorder.

G-29

BAILEY METER COMPANY

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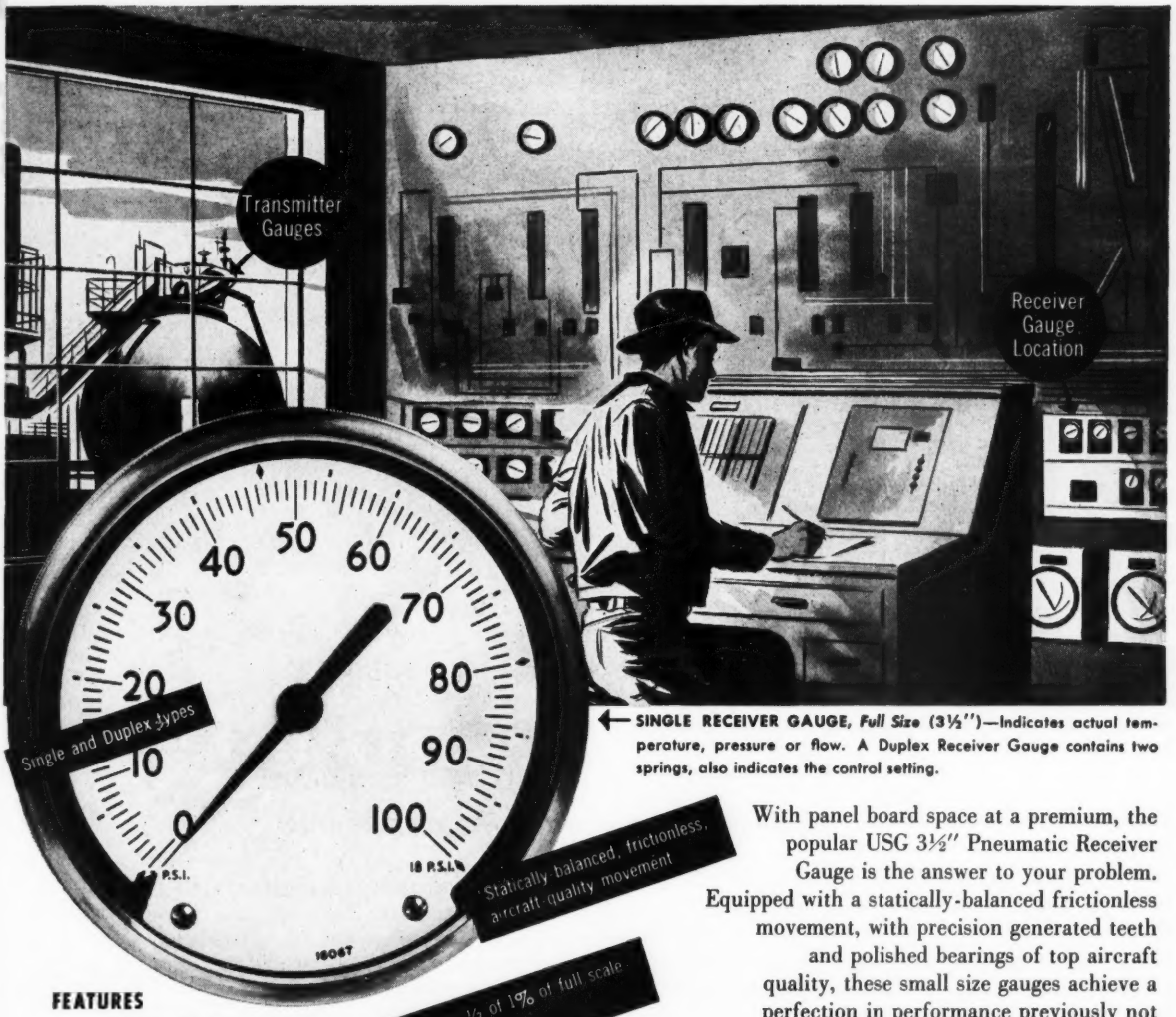
BAILEY METER COMPANY LIMITED, MONTREAL, CANADA

Let Bailey Smoke Density Recorders Watch Your Stacks

Read pressure, temperature or flow at a distance with USG Pneumatic Receiver Gauges



← **SINGLE RECEIVER GAUGE,** *Full Size* **(3½")**—Indicates actual temperature, pressure or flow. A Duplex Receiver Gauge contains two springs, also indicates the control setting.

With panel board space at a premium, the popular USG 3½" Pneumatic Receiver Gauge is the answer to your problem. Equipped with a statically-balanced frictionless movement, with precision generated teeth and polished bearings of top aircraft quality, these small size gauges achieve a perfection in performance previously not thought possible of a pressure gauge.

FEATURES

Ranges: 3 to 15 p.s.i.g. stocked, 3-18 p.s.i.g. also available.
Scale: A variety of scales available.
Case Diam.: 3¾"
Bezel Opening: 3½"
Pressure Elements: Phosphor Bronze, AAA width, stress-relieved.
Movement: Aircraft quality — phosphor bronze and stainless steel.
Adjustments: ±1% maximum linearity adjustment with adjustable tip; micro-adjustable pointer permits rotation with respect to pinion for zero adjustment.
Stops: Zero and over-range.
Case: Drawn steel, black crinkled finish, bevelled glass.
Socket: Extruded brass.

SINGLE OR DUPLEX TYPES—The USG Receiver Gauge is graduated to the same scale as the transmitter gauge yet operates at a very small pilot pressure. It is available with a single spring or double spring (Duplex Receiver Gauge).

GAUGES CARRIED IN STOCK—USG Receiver Gauges are stocked without dials in the range of 3-15 lbs. This permits easy assembly and quick shipment of gauges with dials calibrated to your choosing. Single-spring gauges are available in ¼" low male or center back connection. Duplex gauges are available in low back connection with ⅛" or ¼" male pipe thread and 5/16-28 tubing connection.

United States Gauge, Division of American Machine and Metals, Inc., Sellersville, Pa.

UNITED STATES GAUGE

Quality Gauges Engineered for Enduring Accuracy

PRODUCTS OF UNITED STATES GAUGE... Absolute Pressure Gauges • Aircraft Instruments • Air Volume Controls • Altitude-Gauges • Boiler Gauges • Chemical Gauges • Mercury, Gas, and Vapor Dial Thermometers • Glass Tube and Industrial Thermometers • Flow Meters • Inspectors' Test Gauges • Precision Laboratory Test Gauges • Marine, Ship and Air-Brake Gauges • Voltmeters • Ammeters • Welding Gauges

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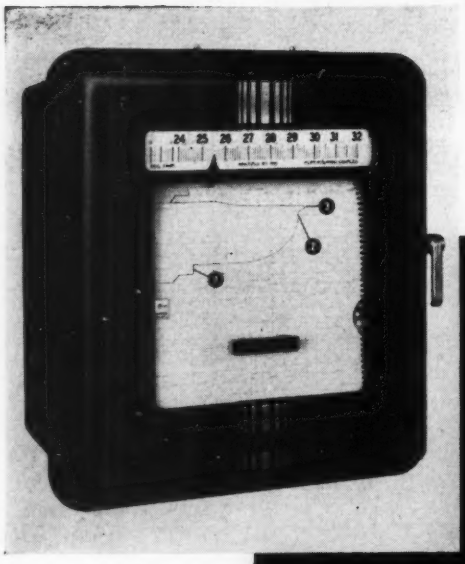
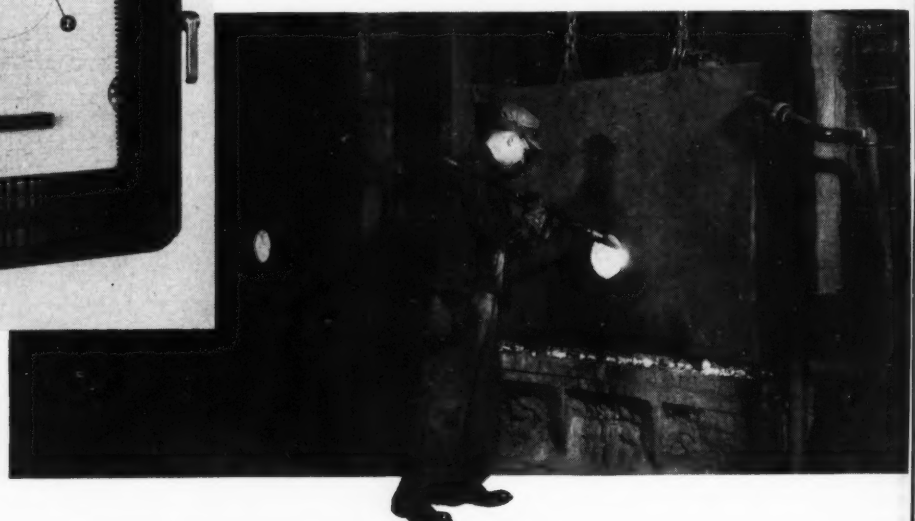


Significant points on chart of Speedomax Immersion Thermocouple Recorder at left are: (1) standardization of recorder circuit during couple immersion; (2) temperature of steel bath, and (3) increase in thermocouple temperature during withdrawal through slag. Entire measuring sequence is swiftly recorded by Speedomax in less than one minute.

In the illustration below, an operator plunges an L&N Immersion Thermocouple, connected to a remotely-located Speedomax Recorder, into the steel bath . . . withdraws it as soon as the Recorder signals that temperature measurement is complete.



Important Speedomax Feature

guards accuracy

of Bath Temperature Measurements

• Now the L&N Immersion Thermocouple Recorder standardizes itself during each measurement . . . helps assure quick, accurate use of immersion thermocouples in measuring temperatures of molten steel.

Occurring only *seconds* before the thermocouple reaches maximum temperature, this adjustment eliminates variations resulting from ambient temperature changes. And since standardization is completely automatic—initiated by each immersion of the couple into the steel bath—the operator is freed of responsibility for this critical detail.

This simplicity characterizes all steps in using the Speedomax Recorder and Signal System for immersion measurements. Signal lights at the furnace, remotely operated by the Recorder, indicate whether the immersion equipment is operable, and warn when bath temperature is reached. Each immersion then results in a significant measurement—and minimum exposure to the high temperature prolongs couple life.

Used with the widely-accepted L&N Immersion Thermocouple, or with *any* immersion couple, the Speedomax Recorder and Signal System promotes improved immersion techniques and reliable measurements . . . results in reduced cost per reading.

For details, write us at 4955 Stenton Ave., Philadelphia 44, Pa., for Folder N-33-640(1), "Measure Bath Temperatures Effectively", or contact your nearest Leeds & Northrup representative.

CAREER OPPORTUNITIES AT L&N

Expansion program of this long-established firm has many features to attract outstanding recent graduates in engineering and science. Opportunities are in sales field engineering, product and application engineering, research, advertising, market development. Widely-respected policies assure recognition of progress and achievement. Address Personnel Manager for preliminary interview at nearest of 17 L&N offices.

Jrl. Ad N-33-640 (3)

LEEDS NORTHRUP

INSTRUMENTS
AUTOMATIC CONTROLS
FURNACES

Editorial Comment

The Seventh ISA Show

TECHNOLOGICAL development of the United States of America was given fresh impetus in every field of scientific and industrial development by the Seventh National Instrument Conference and Exhibit in Cleveland, September 8-12, 1952. Over ten million dollars' worth of instruments for measurement, inspection, testing, analysis, and control were on display—but more important, the world's most advanced techniques for probing the secrets of nature and for producing the world's highest standard of life were proudly exhibited. Far-sighted executives and most of the country's important instrument men took advantage of this wonderful opportunity. The only complaint was that four days was not enough time in which to see 273 exhibit booths and yet partake of the technical papers and clinics running concurrently.

The instrument industry once again displayed its dynamic nature by exhibiting a host of new developments, new models, new techniques, new principles, new designs, new materials.

Pneumatics, Hydraulics, Mechanics

The pneumatic, hydraulic, and mechanical standbys in the field—the controllers and valves that have proved themselves powerful and reliable servants of industry—showed impressive new designs. Ingenuity was displayed in every structural change. For example, a large number of new developments in the design and construction of variable-area and differential flowmeters has produced more accurate, more versatile, more rugged—and less expensive—flowmeters than were available one year ago. Control valves were exhibited in profuse numbers and designs, by more manufacturers than can be named in a short space. Controller units are more reliable, flexible, and serviceable than they were just one year ago. The trend toward miniaturization of all panel-board equipment continues. The graphic panels are still more beautiful and utilitarian.

Electricity and Electronics

Thermistors, transistors, magnetic amplifiers, and other "modern" components are being incorporated in instruments. The electronic circuitry showed interesting improvements—improvements which revealed that the design men of the instrument industry are abreast of those in the communications industry. A remarkable development is the manner in which instrument manufacturers are exploring all regions of the electromagnetic spectrum in their never-ending search for better ways to solve production problems. For example, Fischer & Porter unveiled a resonant-cavity pipe through which pulp flows. A UHF oscillator is placed near the pipe; the absorption of UHF energy by the cavity is a measure of the pulp concentration. As those in the pulp and paper industry know, the measurement of pulp concentration in the industry is a critical and not yet completely solved problem. In the ultrasonic region, the Ultra-Viscoson Corporation displayed a magnetostrictive probe whose ultrasonic vibrations in a medium are used to continuously measure the viscosity of the medium. Infrared, visible, and ultraviolet radiations were shown being used by many types of analytical instruments. Extensive electronic circuitry was used in the many computers and analytical instruments on exhibition.

Computers

The exciting and promising new field of electronic computers, both analog and digital, was presented to American industry at the Show. All aspects of the field were on display, including complete analog computers, complete digital computers, electronic counters (used in radioactivity measurements also), analog-to-digital converters (which change curve-type information into the digital form required by digital computers, IBM cards, etc.), high-speed printers, and large numbers of components (mechanical and electronic). The ultimate use by the industry of such electronic computing instruments will be a revolutionary step in the direction of plant automatization; industry will become the biggest market for computers. The annual instrument exhibit clearly shows the trend and accelerates this healthy development.

Analytical Instruments

The use by industry of many instruments long considered to be "laboratory apparatus" has made indistinct the dividing line between scientific and industrial instrumentation. Analytical instruments, which have completely bridged the fields, are now being used by industry in such volume that all industrial-instrument men are learning the principles and servicing of this type of equipment. The Analytical Clinic, directed by Dr. Axel Peterson of Mellon Institute, provided a unique opportunity to gain perspective and detailed information about this important and new field of instrumentation. Nowhere else and never before have technical men had the opportunity to study and examine, within a few days, the equipment, principles, and operation of X-ray diffraction equipment for atomic and molecular analysis of organic and inorganic materials (North American Philips), infrared spectrophotometers for analysis of organic solutions (Perkin-Elmer), vacuum techniques and molecular analysis by light-scattering and differential-refractometer instruments (Process & Instruments), leak detection by inert-gas mass-spectrometer technique (Consolidated Engineering), flame-spectrophotometry analysis (Beckman Instruments), radioactivity instrumentation (General Electric), thermal-conductivity analysis of various gases, fuels, and fuel/air ratios (Gow-Mac Instrument Co.), infrared-absorption plant-stream analyzer (Baird Associates), and combustible gas, oxygen, and Luft-type infrared analyzers (Mine Safety Appliances). Many years of experience and education were packed into this clinic; those who attended gained invaluable knowledge and techniques.

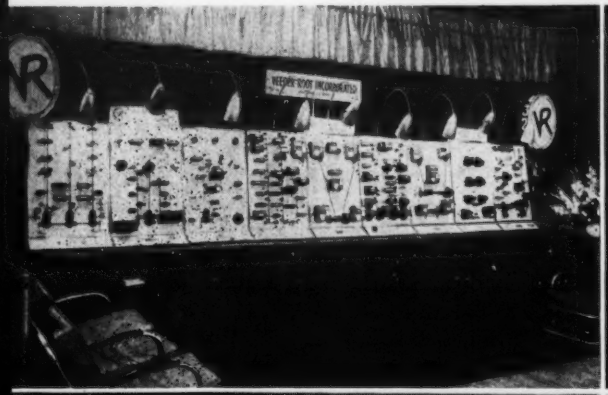
Medical Instrumentation

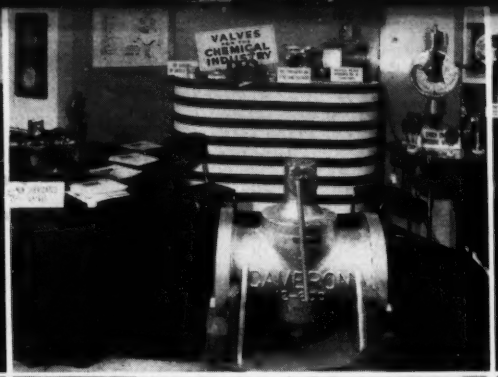
Three sessions under ISA auspices were devoted to "medical" (actually biological) instrumentation. They deserve special mention here because they were the first such sessions held at an ISA Conference; because the twelve papers presented at these sessions included several disclosures of the highest importance; and because they mark the beginning of one more much-needed open forum where biological scientists can exchange ideas with skilled Instrument Men.

The Instrument Exhibit & Conference offered all of American industry and its technical workers an unparalleled opportunity to see and learn the world's best methods for learning, examining, analyzing, testing, and controlling the forces of nature for the good of mankind. All who attended benefited themselves, their companies, and their country.—MFB & MHA

INSTRUMENT-COMPANY EXHIBITS AT CLEVELAND, SEPTEMBER 8-12

On these eleven pages *Instruments* takes pleasure in reproducing ALL the photographs of commercial exhibits received up to closing-date for this October issue; also the NBS and Navy Exhibits. Total, 173.

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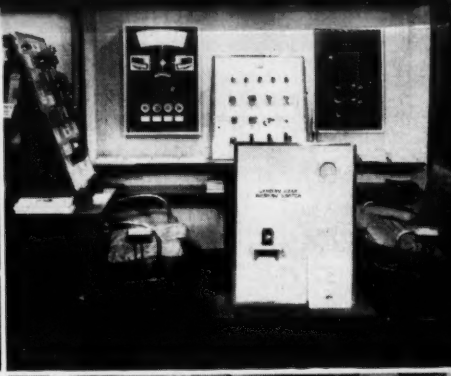
INDUSTRY



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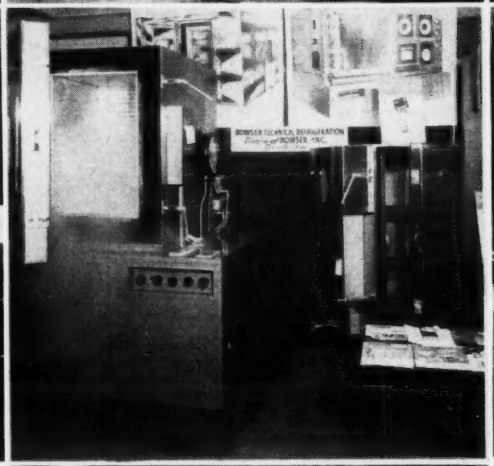

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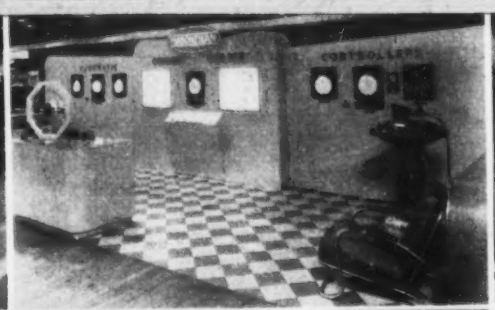

PALMER THERMOMETERS
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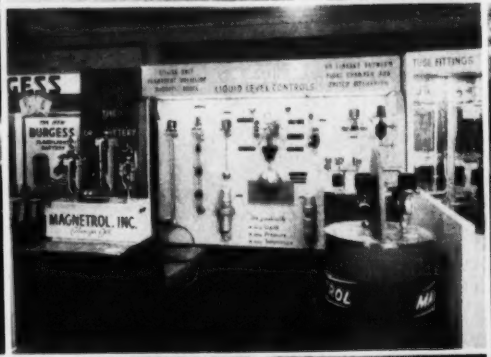
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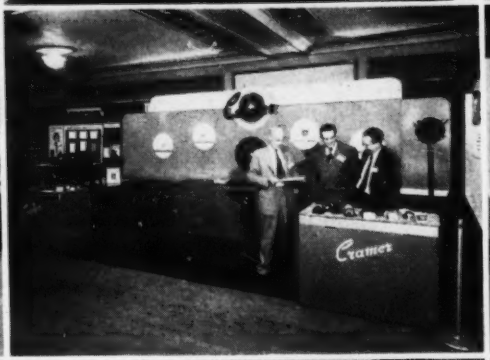
Cramer

J.R. DANNEMILLER ASSOCIATES
MINIATURE
BALL
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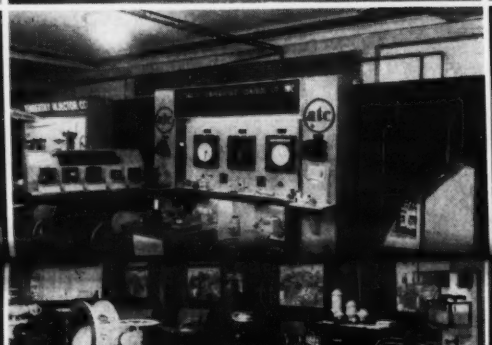

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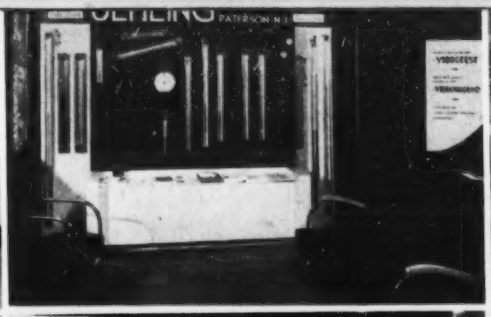

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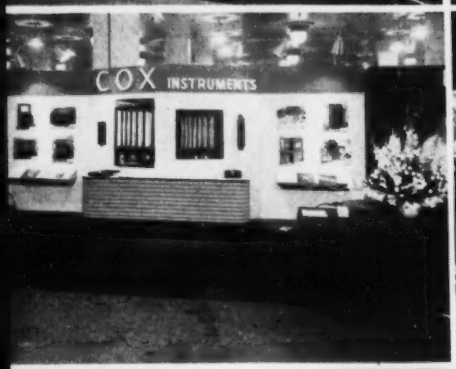
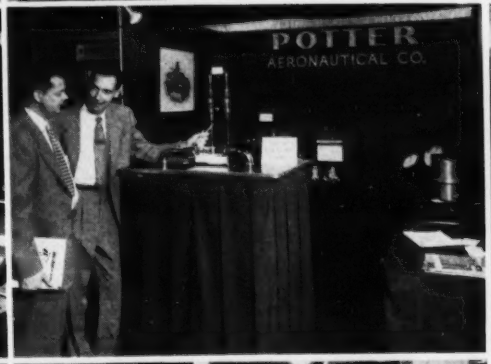

COX INSTRUMENTS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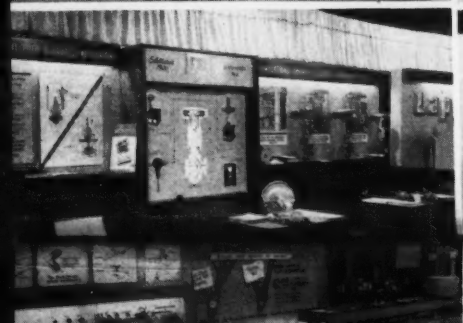

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wheelco instruments
MAROTTA VALVES
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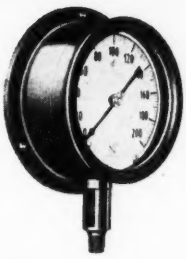
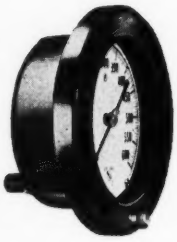


Choice of 7 Case Designs

WHEN YOU SPECIFY

ASHCROFT DURAGAUGES



SPECIFIC NEEDS are your best guide in selecting a pressure gauge casing. Ashcroft Duragauge Casings, made in three distinctly different types of material and seven different designs, meet practically every installation and service requirement:

ALUMALIFE®—a special aluminum alloy that is light, strong and has excellent overall resistance to corrosion and vibration.

CAST IRON — tough and durable. Used in corrosive conditions where aluminum would not be suitable.

PHENOL — light, strong, rigid plastic that is acid-proof and corrosion proof.

Every Duragauge case is dust and moisture-proof, and the entire gauge system can be easily removed from the case *as a unit.*

To insure peak performance and maximum service life in specific installations, you can choose an Ashcroft Duragauge with the Bourden Tube made of any one of eight different types of materials. All provide unusually long tip travel, consequently greater accuracy of indication is assured. The patented Nylon Movement outwears all others. And the micrometer adjustment pointer is easy to get at and reset precisely while on the shaft.

Remember, only Ashcroft Duragauges give you all these advantages. So — ask the nearby Ashcroft Distributor to help you choose Duragauges that fit your needs exactly.

ASHCROFT DURAGAUGE CASE MATERIALS, MOUNTING AND DIAL SIZES

CASE	BACK FLANGE	MOUNTING		CONNECTION		DIAL SIZE
		WALL	FLUSH	LOWER	BACK	
Black Alumalife® with flat, threaded Alumalife ring	Yes	Yes	Yes	Yes	Yes	4½", 6"
Black Cast Iron with flat, threaded ring of Alumalife on 4½" and 6" and Bronze on 8½", 10" and 12"	Yes	Yes	Yes	Yes	Yes	4½", 6" 8½", 10", 12"
Black Phenol Turret with snap ring	No	Yes	Yes	Yes	Yes	4½", 6", 8½"
Black Phenol with threaded phenol ring. Safety blowout disc is standard	Yes	Yes	No	Yes	Yes	4½", 6", 8½"
Black Alumalife with special ring held tightly at top by a hinge pin and at bottom by a clamp screw	No	No	Yes	No	Yes	4½", 6", 8½"
Black Cast Iron with special ring held tightly at top by a hinge pin and at bottom by a clamp screw	No	No	Yes	No	Yes	4½", 6", 8½" 10", 12"
Black Alumalife with black clamp slip ring	Yes	Yes	No	Yes	No	4½", 6"

1850 ASHCROFT U.S.A.

ASHCROFT GAUGES

MAXWELL MANNING & MOORE TRADE MARK

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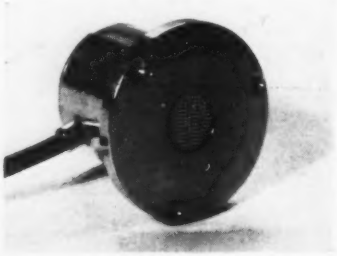
The Month's NEW INSTRUMENTS

In this department we report each month new devices for measurement, inspection, testing, computing, metering and automatic control—in the form of concise technical descriptions.

FOR FURTHER INFORMATION USE THE POSTAGE-FREE ORDER CARD ON PAGE 1477

Pressure Pickup

New "Type 3 Electrokinetic Pressure Transducer" utilizes streaming potential developed by a polar liquid flowing through a porous plug to provide a high-sensitivity means of measuring

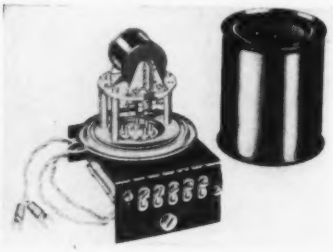


fluctuating or transient pressures over extended amplitude and frequency ranges. In configuration shown, case may be baffle-mounted for measuring air blasts and shock waves up to 100 psi. or adapted to measure pressures in pipes or tubing. Sensitivity, 250 mv./psi. at a resistive output impedance of less than 100,000 ohms. Frequency response at diaphragm, 0.25 cps. to above 30 kc. Unit requires no external power source. Sensitivity at midband frequencies is unaffected by cable length. 95-percent rise time with 2-ft. cable is about 15 microseconds. Noise level equivalent of well below 0.00005 psi. makes it possible to accurately measure sound pressures as low as 0.0001 psi. A useful pressure range of over 1,000,000:1 is measureable in the same frequency response range with the same unit. Supplied in other configurations, basic cell may be used as a microphone, hydrophone, accelerometer, etc.—*The Beta Corp., P. O. Box* 8625, *Richmond* 26, *Va.*

Mention No. 1301 when filling out card.

Synchronous Inverter

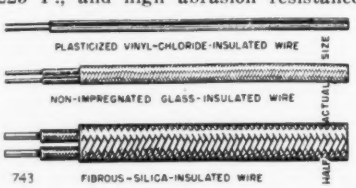
New "Syncroverter Switch" is a synchronous inverter having a sensitivity of 0.05 microvolts and a dissymmetry of less than 0.5 percent, capable of converting low-power d-c. signals, as low as 0.05 microvolts, to alternating voltages that can be amplified and applied to electronic, electrical and servo systems. It will operate at any frequency from zero to 3500 cps. and is designed for precision use in electronic computers, instruments, gun directors, null detectors, etc. Instantaneous operation and length of life are said to be unaffected by vibration or shock. Errors due to thermal emf. are eliminated by the use of two single-pole double-throw contacts. Contact-carrying armatures are of such low mass that their mechanical response is practically instantaneous. Unit is free from resonance effects; is hermetically sealed against dust and corrosion. "Syncroverter Switch" is also furnished with two separate and independent s-p.d-t. contacts for use, for example, on input and output of a d-c. amplifier.—*The Bristol Co., Waterbury* 20, *Conn.*



Mention No. 1302 when filling out card.

Thermocouple Wires

Three new types of thermocouple wire-pairs are announced: (1) Plasticized vinyl-chloride-insulated, made by covering each of two conductors with multiple coats of color-coded and baked insulation; conductors placed side-by-side and firmly bonded together by plastic cement. Advantages include true moisture-proofing, safe flexure at ambient temperatures from sub-zero to 225 F., and high abrasion resistance.

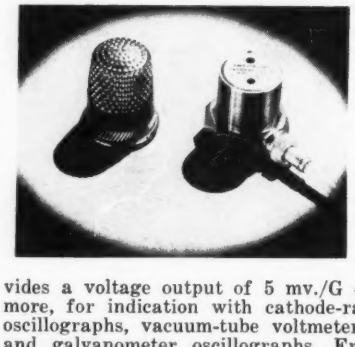


(2) Non-impregnated glass insulation: conductors, placed side-by-side, are covered with braided glass insulation; then heat-treated to remove stresses in glass yarn to make insulation resistant to fraying when wire is cut or abraded. Insulation is not color-coded but a magnet provides a simple means of identification: iron conductor in I-C and Alumel in C-A are magnetic. Insulation resistance does not decrease at high temperatures. Among applications: making temperature-distance curves of continuous traveling ovens, furnaces and dryers. (3) Fibrous silica-insulated is similar in fabrication to non-impregnated glass-insulated: finished wire is insulated with a braid of fibrous silica on individual conductors, plus a loose over-all braid of same material; insulation is then lightly impregnated with a butyrate lacquer. Not color-coded, but Alumel conductor is magnetic. This wire is claimed to have good dielectric strength; has abrasion resistance up to 1600 F.; is recommended for jet engine temperature testing, creep testing, batch annealing, etc.—*Industrial Div., Minneapolis-Honeywell Regulator Co., Philadelphia* 44, *Pa.*

Mention No. 1303 when filling out card.

Accelerometer Pickups

New "Series 2200 accelerometers" are of small size and light weight (0.55 oz.). Each unit is a self-generating pickup with excellent temperature and mechanical stability, which pro-

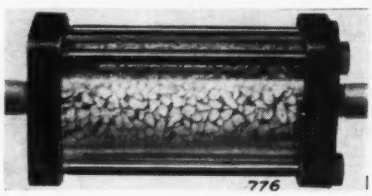


vides a voltage output of 5 mv./G or more, for indication with cathode-ray oscillographs, vacuum-tube voltmeters, and galvanometer oscillographs. Frequency range 5 to 5000 cps. Among applications: blast effect studies; structural drop studies; ballistic studies; transient loads of structures; shock acceleration analysis; feedback control for servomechanisms using high-speed moving elements; frequency and amplitude measurements of members under test for stress and resonance characteristics; calibration of vibration and shake tables.—*Endevco Corp.,* 180 *East California St., Pasadena* 1, *Calif.*

Mention No. 1304 when filling out card.

Air-line Moisture Indicator

New Air Line Moisture Indicator gives a positive visual indication of presence or absence of moisture in air or gas line; consists of a Pyrex glass



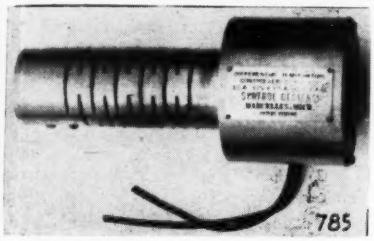
cylinder filled with moisture-sensitive blue granules; has end plates tapped for quarter-inch pipe; is placed in line between air supply and point at which air is used. Granules stay blue as long as air leaving Indicator is dry, and turn pink when it contains moisture or water vapor. All units with glass cylinder are factory tested at 100 psi.; units with clear plastic cylinders can be furnished for higher pressures. Over-all length, 5 in. Pressure drop, less than 1 in. of water at flow-rate of 5 cfm.—*King Engineering Corp., Ann Arbor, Mich.*

Mention No. 1305 when filling out card.

Makers of these and other types of instruments are listed in THE INSTRUMENTS INDEX

Differential Thermostat

New "Style 101 Differential Thermostat" prevents condensation from forming on inside surfaces of outdoor enclosures by maintaining inside temperature a fixed amount (say 10 deg.) higher than outside temperature, regardless of outside temperature variations. Applications include switchgear

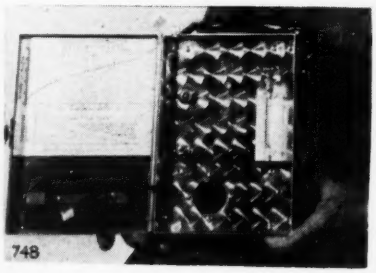


cubicles, control houses, mechanism houses, etc. It insures that supplemental heat is full on when necesary during a rapid outside temperature rise; prevents excessive inside summer temperatures; saves money in heat costs and heater life; is designed to mount through a sheet-metal wall.—*Syntrol Designs, Box* 105, *Marcellus, Mich.*

Mention No. 1306 when filling out card.

Odor Meter

New model of "Odorometer" simulates room test for determining threshold detection, odor strength, and odor character of odorized natural gas or odorized LP-Gas. A 110-volt constant-speed electric motor driving a small turbine blower delivers a constant vol-



ume of air, into which odorized gas sample is measured through a rotameter. "Sniff" tests of effluent stream permit judging characteristics and intensities of odorized gas. By means of a calibration chart, percent gas in air can be determined.—*Oronite Chemical Co., 38 Sansome St., San Francisco, Calif.*

Mention No. 1307 when filling out card.

Precision Bridge for Temperature Measurements

New "Type BU-1000 Speed Bridge" is intended to indicate temperatures to 0.001 C. over restricted range. It is provided with a 1000-division 10-turn slide wire. If range is made 1 degree, one division will indicate a temperature change of approx. 0.001 degree. New bridge arms can be plugged in to change range. Significant bridge arms are located under a hood with a heater and thermostat to keep them at constant temperature. Instrument is said to be as rugged and stable as other members of "Speed Bridge" family, but is provided with an amplifier of slightly

Makers of these and other types of instruments are listed in THE INSTRUMENTS INDEX

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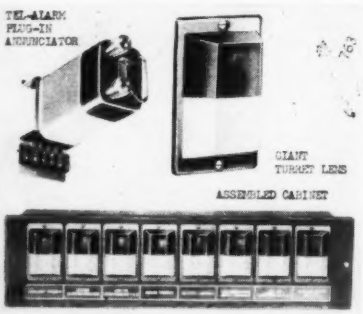
higher gain and a more sensitive null indicator. Weight 15 lbs. Steel case 7 x 8 x 12 in.; Bakelite veneer panel. Power supply 115 v.ac.—*Weiller Instruments Corp., 95 Broad St., New York 4, N. Y.*

Mention No. 1308 when filling out card.

Alarm Signal Lenses

New "giant turret lenses" for "Tel-Alarm" system permit visibility of a warning light at distances at least three times as great as with conventional bull's-eye types; are made of a durable plastic material with a wide choice of colors available. Each lens has two sections which correspond to the two lights of "Tel-Alarm" signals: upper portion one color and lower usually white



frosted. With these lenses on annunciators, it is possible for operator of control room to see at a glance which alarm signal is flashing. New lens also affords more clearance for light which fits inside it. (No chance for bulb to be pushed out of alignment and contacts broken.)—*Tigerman Engineering Co., 4332 North Western Ave., Chicago, Ill.*

Mention No. 1309 when filling out card.

OPTICAL INSTRUMENTS

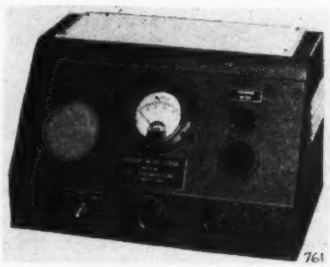
Metallographic Microscope

New "Me CSM" metallographic microscope (made in Austria) is available for work with (A) Reflected light (bright or dark field); (B) Reflected light (bright and dark field); (C) Reflected polarized light. Features include (1) Interchangeable body tube, straight monocular or inclined binocular; (2) Vertical illuminators for bright and dark field or simplified ones for either bright or dark field; (3) Object stage interchangeable, square and round models available; (4) Stand fitted with a rack-and-pinion movement to raise and lower stage; (5) Adequate working distance; (6) Instant transition from ordinary to polarized light.—*William J. Hacker & Co., Inc., 82 Beaver St., New York 5, N. Y.*

Mention No. 1310 when filling out card.

Exposure Meter Tester

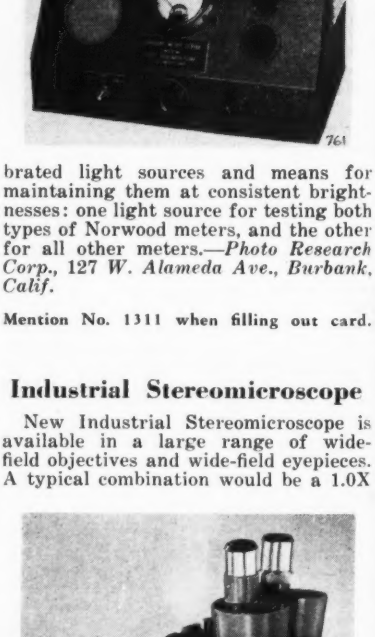
New exposure meter tester quickly checks performance of any type of photoelectric exposure meter now on market; requires no special skill to operate; comprises two accurately calibrated light sources and means for maintaining them at consistent brightnesses: one light source for testing both types of Norwood meters, and the other for all other meters.—*Photo Research Corp., 127 W. Alameda Ave., Burbank, Calif.*



Mention No. 1311 when filling out card.

Industrial Stereomicroscope

New Industrial Stereomicroscope is available in a large range of wide-field objectives and wide-field eyepieces. A typical combination would be a 1.0X objective in combination with a 10X eyepiece, which would give 10X magnification with a 0.79-in. field and a 3.77-in. working distance. Through other combinations, magnification up to 150X is possible. When built into a machine,



Makers of these and other types of instruments are listed in THE INSTRUMENTS INDEX

a *new* concept in OSCILLOGRAPHY

the new DU MONT Type 304-A

The new Du Mont Type 304-A, succeeding the world-famous Type 304-H, is more than simply a new instrument – more than a new combination of established circuits. It represents a significant development in the science of instrumentation. The Type 304-A is *a true electronic voltmeter*. This reflects a new concept in oscillography. Every feature of the Type 304-A has been evaluated with this concept in mind. All of the features that made the Type 304-H so valuable as a qualitative instrument have been preserved and augmented to enable not only qualitative analyses, *but rapid, accurate quantitative amplitude measurement* as well. The novel amplitude calibrating system of the Type 304-A permits signal measurements from the screen *directly in volts*. Unlike electro-mechanical devices, the new Type 304-A is not restricted to measurement of sinusoidal signals – or peak-to-peak values of voltage. The Type 304-A may be used to measure any amplitude portion of signals within its performance specifications.

SPECIFICATIONS:

CATHODE-RAY TUBE – New Flat-Face Type 5ADP-
ACCELERATING POTENTIAL – 3000 volts.
Y-AXIS: ***Deflection Factor*** – Through amplifier, 0.1 p-p volts FULL SCALE (equivalent to 0.025 p-p volt/inch). Direct, 32-39 p-p volts/inch.
Frequency Response – Direct coupling: flat to 0. Down not more than 10% at 100,000 cps. Capacitive Coupling; down not more than 10% at 10 and 100,000 cps. Down not more than 50% at 300,000 cps. Provision for balanced input on 0.1 VOLT-FULL-SCALE range.
Undistorted Deflection – More than 4 inches.
Expansion – Equivalent to 20 inches.
Input Impedance – *Amplifier:* (single ended) 2 megohms 50 $\mu\mu$f; (balanced) 2 megohms, 35 $\mu\mu$f. *Direct:* (single ended) 1.5 megohms, 20 $\mu\mu$f; (balanced) 3 megohms, 20 $\mu\mu$f.
X-AXIS: ***Deflection Factor*** – Through amplifier, 0.3 p-p volt/in. Direct, 40-50 p-p volt/in.
Frequency Response – Direct coupling: flat to 0. Down not more than 10% at 100,000 cps; down not more than 50% at 300,000 cps. Capacitive coupling: Down not more than 10% at 10 and 100,000 cps. Down not more than 50% at 300,000 cps.
Undistorted Deflection – More than 4 inches.
Expansion equivalent to 30 inches.
Input Impedance – *Amplifier:* 2.2 megohms, 50 $\mu\mu$f. *Direct:* (single ended) 1.5 megohms, 20 $\mu\mu$f; (balanced) 3 megohms, 20 $\mu\mu$f.
LINEAR SWEEPS: ***Sweep Frequency*** – Recurrent and driven sweeps continuously variable from 2 to 30,000 cps. Maximum sweep-writing-rate, 1"/μsec. Provision for sweeps of extra-long duration; ½ sec. of sweep obtained for each microfarad of external capacitance.
Synchronization – from signal of either polarity.
Sync Limiting – on both driven and recurrent sweeps.
VOLTAGE MEASUREMENT – Squarewave standard applied for calibration by front panel push button.
Voltage Range: VOLTS FULL SCALE, 0 to 0.1, 1, 10, 100 volts. MULTIPLIER: x1 to x10
Overall Accuracy: 5%
INTENSITY MODULATION – 15 volts blanks beam at normal intensity settings.
CALIBRATED SCALE – Variable illumination. Numbered calibrations for amplitude measurement.
PRIMARY POWER – 115 or 230 volts. 50-400 cps. 110 watts.
PHYSICAL CHARACTERISTICS – Metal cabinet with grey wrinkle finish. Dimensions: height 13½", width 8¼", depth 19½". Weight 50 lbs.

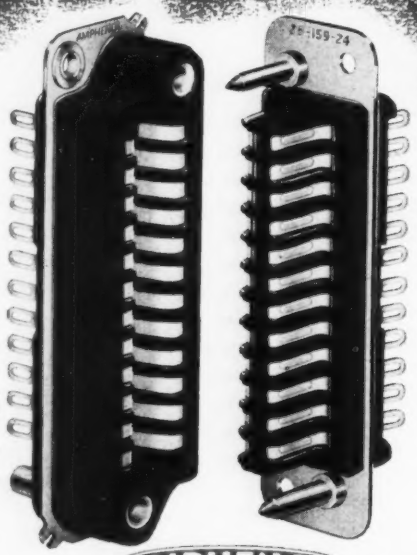
CALIBRATING the Type 304-A is as simple and easy as zeroing a vacuum-tube voltmeter. Depressing the CALIBRATOR push button on the front panel applies a square wave signal of precisely 0.1 p-p volt to the amplifier. The MULTIPLIER control is then adjusted for full scale deflection (4 inches) so that the peaks are at 0 and 100. Amplitude may now be read directly from the scale where four inches vertically indicate 0.1, 1, 10, or 100 volts, as determined by VOLTS FULL SCALE selector. Depressing the CALIBRATOR push button again, returns signal applied to Y-input terminals to the screen.

The MULTIPLIER control also permits calibration of the scale to other values. For, say, 200 volts-full-scale, the MULTIPLIER control is adjusted near 2 so peaks of squarewave are at zero and 50 on the scale. Amplitude may now be measured directly in volts simply by multiplying the scale reading by the setting of the MULTIPLIER control (2) and the VOLTS FULL SCALE setting (100). Use of the MULTIPLIER control extends the range of the Type 304-A to 1000 volts-full-scale.

DOMESTIC PRICE $333.00

ALLEN B. DU MONT LABORATORIES, INC., INSTRUMENT DIVISION - 1500 MAIN AVENUE, CLIFTON, NEW JERSEY

NEW

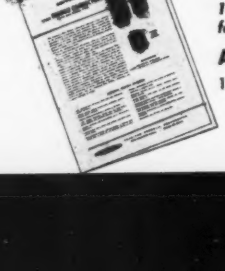


AMPHENOL

BLUE *RIBBON CONNECTORS*

- Low insertion and extraction force with high individual contact pressure.
- Unique spring contact construction maintains positive contact under vibration.
- Wiping action insures positive contact at all times.
- 1-501 (Diallyl Phthalate) plastic used has high dimensional stability and excellent dielectric properties.
- Contact terminals will accommodate up to #16 stranded conductors.
- Contacts have heavy silver base plating with gold as the surface finish.
- Gold finished contacts will not tarnish or corrode and remain easy to solder for an indefinite period of time.
- Positive polarization prevents mis-mating of connectors.
- Connector is ruggedly built.
- Protective barriers between contact terminals insure proper spacing.
- Sturdy contacts resist abuse—are not easily damaged by test prods, etc.
- Corrosion resistant, passivated stainless steel, molded-in mounting plates provide a sturdy mounting.
- Float-mounted receptacle allows for possible mis-alignment of mating plug and receptacle.
- Provision incorporated to prevent tilting of float-mounted receptacle.
- Connectors pass 50 hour salt spray test.

AMPHENOL



For complete information on the New Amphenol Blue Ribbon Connectors, write Dept. 13C for a copy of this four page bulletin.

CROSS SECTION

AMERICAN PHENOLIC CORPORATION

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assembly, or inspection set-up, new microscope provides for continuing observation of operation so that manufacturing and inspection standards can be adhered to. It embodies vertical eyepiece tubes with adjustments for interpupillary distance and balancing acuity of observer's eyes, binocular dustproof prism bodies, and illuminator socket.—*Bausch & Lomb Optical Co., Rochester 2, N. Y.*

Mention No. 1312 when filling out card.

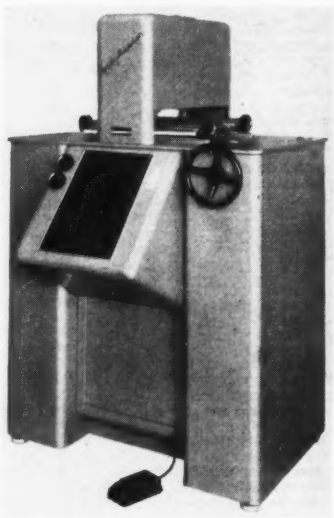
Phase-contrast Accessory for Camera Microscope

New phase-contrast equipment is available in U. S. for "Reichert Universal Camera Microscope" (made in Austria) which was illustrated and described in July 1952 *Instruments*, page 872.—*William J. Hacker & Co., Inc., 82 Beaver St., New York 5, N. Y.*

Mention No. 1313 when filling out card.

Microphotometer for Spectrography

New "Spec-Reader" is a comparator-microphotometer (or microdensitometer) for high-accuracy quantitative analyses as well as rapid qualitative

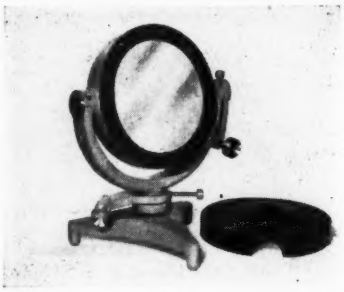


and semi-quantitative work. Viewing screen is largest available: 10 x 14 in.; and maker states that more conveniences are incorporated than ever before obtainable. Line being measured is always in view. Scanning is achieved through a 12-micron line of light at emulsion for lowest Schwartzchild-Villiger effect. Stability factors: all adjustments permanent or out of reach of "knob-twirlers"; no focus extremely critical; warm-up period about 5 minutes; zero drift and full-scale drift less than 0.5 percent. Magnification is 17X at screen.—*National Spectrographic Sales Corp., 6300 Euclid Ave., Cleveland 3, Ohio.*

Mention No. 1314 when filling out card.

Precision Schlieren Mirrors

New series of first quality spherical and plane aluminized mirrors (made in England) specifically designed for Schlieren observation and photography, are available in a number of standard

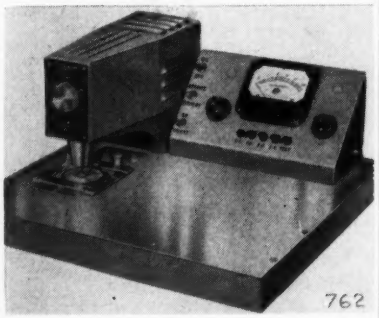


sizes from 4 to 18 in. diameter. Spherical mirrors available in various focal lengths. Precise mechanical mounts permit coarse and fine adjustment about vertical and horizontal axes. Detachable metal covers are provided.—*Photographic Instrumentation Div., J. A. Maurer, Inc.*, 37-01 31*st Street, Long Island City* 1, *N. Y.*

Mention No. 1315 when filling out card.

Color Densitometer

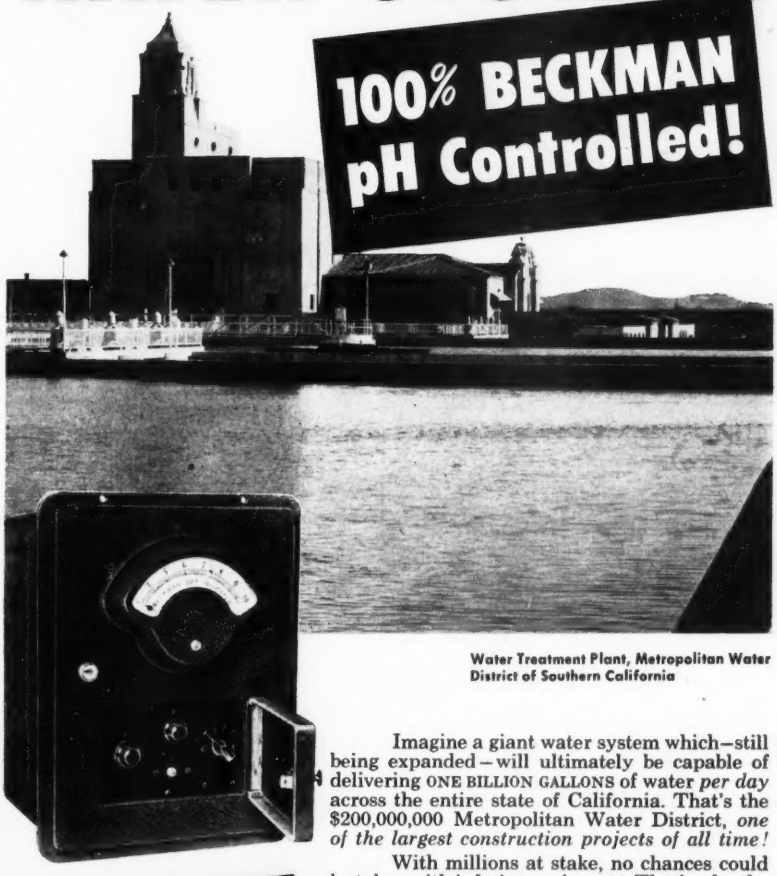
New "Model III Color Densitometer" is especially designed for color sensitometry. Light from lamp passes through a chopper wheel, through heat- and infrared-absorbing filters, then



through a filter wheel containing filters having narrow transmission bands in blue, in green and in red. Light beam is then focused to pass through film sample, picked up by a high-vacuum phototube and applied to an extremely stable high-gain a-c. amplifier containing large negative feedback to produce high linearity and freedom from tube drift. Amplifier output is rectified and drives an indicator having inverse-log response, producing a scale having linear density divisions. A push-button range switch selects density range of 0 to 1, 1 to 2, 2 to 3 or 3 to 4; hence total scale spread for 0 to 4 density of more than 12 inches; also an electrical density of 1 on a fifth push-button which makes instrument selfcalibrating. Illuminated Lucite disk surrounding phototube aperture enables operator to locate area he wishes to measure without additional marking. A slip-on adjustable guide for 35mm. m-p. film is also furnished. In addition to narrow-

Makers of these and other types of instruments are listed in THE INSTRUMENTS INDEX

One of the
WORLD'S LARGEST WATER SYSTEMS



Water Treatment Plant, Metropolitan Water District of Southern California

Imagine a giant water system which—still being expanded—will ultimately be capable of delivering ONE BILLION GALLONS of water *per day* across the entire state of California. That's the $200,000,000 Metropolitan Water District, *one of the largest construction projects of all time!*

With millions at stake, no chances could be taken with inferior equipment. That's why the Automatic pH Control on this vast project is *100%* BECKMAN! In the giant treating plant where the water is softened and purified, BECKMAN pH Instruments control the pH of the liming process . . . the pH of the carbonation process . . . and the pH of the final treated water. *No finer tribute than this 100% installation could be paid to the unfailing dependability and outstanding quality of* BECKMAN *pH Equipment!*

INSTALLED 1942—10 YEARS' SERVICE with negligible maintenance—typical of Beckman dependability!

What you can do with Beckman pH Control!

The Beckman Model R Automatic pH Indicator in conjunction with standard recorder-controllers provides automatic continuous pH measurement and control in a wide variety of industrial processes. May be wall or panel-mounted. Measurements can be made on grounded solutions permitting Beckman Immersion or Flow Electrode Assemblies to be installed directly in pipe lines and vats—eliminating need for grab sampling. You can set the instrument to maintain optimum pH condition at all times thus insuring more uniform control . . . eliminating "overdosing" and waste of chemicals.

Provides easily-read six-inch scale in three standard ranges: 0 to 7 pH, 3 to 10 pH or 6 to 13 pH in 0.1 pH divisions. Two other Model R-type instruments are also available: The Model RX Amplifier for use where an indicating meter is not desired; the Model RM Millivolt Indicator for measurement of oxidation-reduction potentials. Standard operation with 115-v. 50/60 cycle current. Send for your free copy of Data File 81-47

BECKMAN INSTRUMENTS control modern industries

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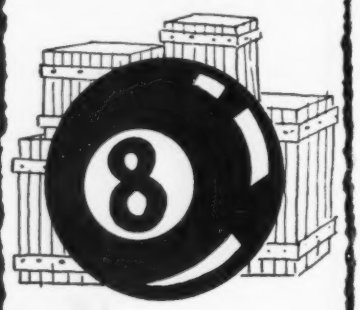
BECKMAN INSTRUMENTS include: pH Meters and Electrodes · Spectrophotometers · Radioactivity Meters · Special Instruments

are your
DELIVERIES



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- Continuous Duty Rated
- Reliable-Efficient-Economical

Other models available
to ¾ hp.

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band blue, green and red filters, two additional filters correct lamp-phototube system to that of human eye and to that of color-blind reproduction material. When these filters are used in conjunction with special diffusion cone aperture plate furnished, densitometer reads diffuse visual density and diffuse print density respectively. Long throat of instrument makes it possible to read to center of an 11 x 14 in. film or plate. —*Photo Research Corp., 127 W. Alameda Ave., Burbank, Calif.*

Mention No. 1316 when filling out card.

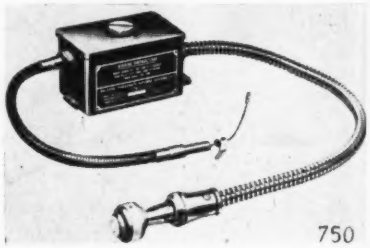
Inspection Magnifier

New 10-power magnifier, for inspection and precision machining, can be used alone or with special illuminating attachment.—*Eder Instrument Co., 2293 N. Clybourn, Chicago 14, Ill.*

Mention No. 1317 when filling out card.

Automatic Parachute Ripcord Release

New automatic parachute ripcord release, designed for sonic speeds and stratospheric conditions, allows pilot to drop as rapidly as a free fall will allow him to a warmer and lower level and then automatically releases ripcord. It combines an altitude sensor and a timing mechanism: At a predetermined height, altitude sensor trips timer which allows a preset number of seconds to elapse before 'chute opens. —*U. S. Gauge Div., American Machine & Metals, Inc., Sellersville, Penna.*



Mention No. 1318 when filling out card.

Measuring Microscope

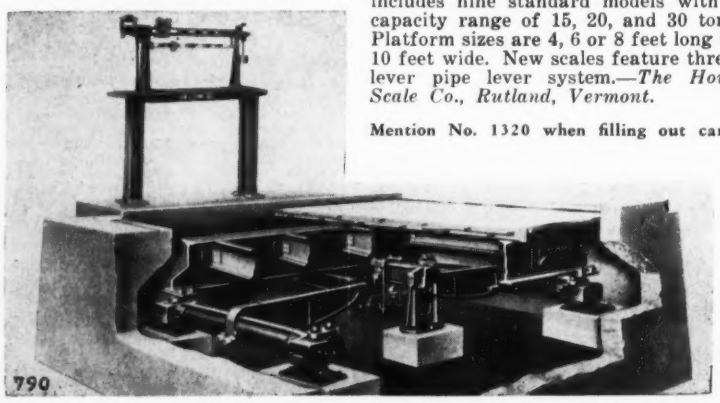
New "Optometer" 50-power pocket measuring microscope has an engraved scale mounted in body tube reading directly to 0.002 inch. Precision lenses, fully corrected for color and spherical aberration, result in a sharp image up to edge of field of vision. In use, "Optometer" is placed on surface of part to be inspected and a light directed obliquely toward tapered opening; focusing knob is moved until object is in focus; linear dimension is read directly. Leather carrying case is supplied. — *National Instrument Co., 5005 Queensbury Ave., Baltimore, Md.*

Mention No. 1319 when filling out card.

Axle Load Scales

New heavy-duty axle load scales comply with state laws and protect commercial carriers from stoppages, load transfers and fines. Complete line includes nine standard models with a capacity range of 15, 20, and 30 tons. Platform sizes are 4, 6 or 8 feet long by 10 feet wide. New scales feature three-lever pipe lever system.—*The Howe Scale Co., Rutland, Vermont.*

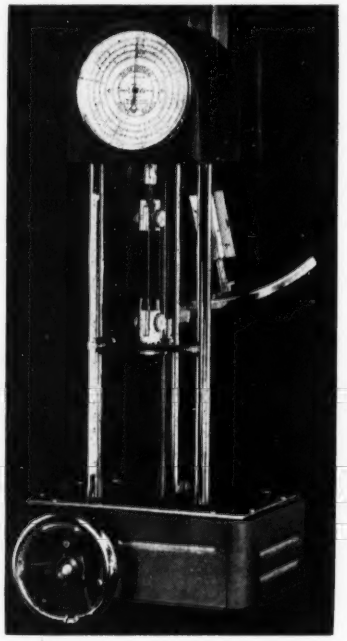
Mention No. 1320 when filling out card.



Makers of these and other types of instruments are listed in THE INSTRUMENTS INDEX

Testing Machine

New hand-operated "Multi-Low-Range" testing machine is for test programs where it is desirable to apply a load to specimens with extremely slow

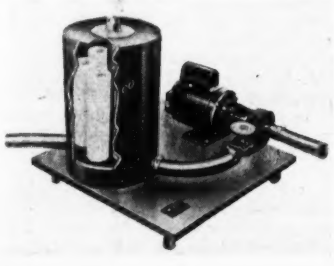


speed and load must be capable of being stopped instantly. Tester is available with following grip clearances: 14.75 in., 24 in., 36 in., and 48 in. Basic dial has four individual scales: 10-lb. range with ½-lb. divisions; 25-lb. range (1-lb. div.); 50-lb. (2-lb.); 100-lb. (5-lb.). A supplementary dial is available calibrated for 0-300-lbs. with 1-lb. divisions. Accuracy of new tester is guaranteed to within 0.5 percent. Maximum readings are easily obtained since pointer remains at peak load after specimen breaks. Elongation readings are provided by means of a special elongation scale and traveling hair line affixed to moving platen. Tests can be made in tensile, compression, transverse and shear. Over-all height 64 in.; net weight 170 lbs.—*W. C. Dillon & Co., Inc., Forest Park, Illinois.*

Mention No. 1321 when filling out card.

Filter Pumps

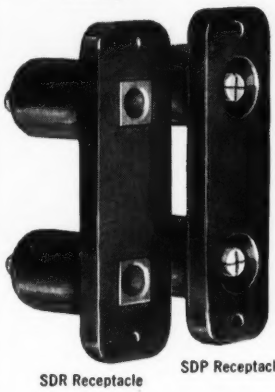
New "ASI Series" filter pumps are designed and constructed to produce sparkling filtration of practically any acid or alkaline solution from pH 1 to



CANNON PLUGS *for laboratory and switchboard*

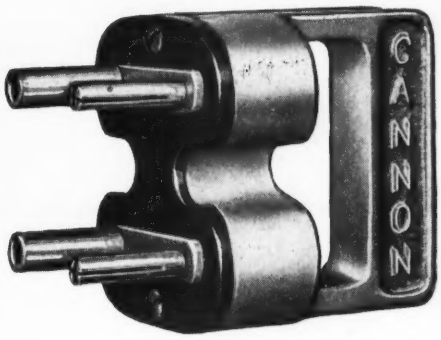
Here are a few examples of Cannon's Experimental Laboratory and Switchboard Connectors. They are used extensively throughout industry, public utilities, sound studios, broadcasting stations, college and university physics and chemistry laboratories, in AC network analyzers and electronic analog computers. They may be applied wherever quick disconnect switching

CSR Tandem Receptacle
CSP Plug



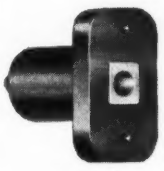
SDR Receptacle

SDP Receptacle



SWPR-4 Switching Plug having both pin and socket contacts

and patch cord plugs are required. High grade materials are used throughout. Molded phenolic of high dielectric strength is used for insulation. Both pin and socket contacts are machined from solid brass. Some are silver plated. All are rated at 75 amps. Pin contacts are split for low loss seating in tapered bore sockets. Single contact fittings are supplied in either red or black phenolic to designate direct or alternating current circuits respectively. Two-contact and larger plugs have sand-blasted cast aluminum shells and handles with clear lacquer finish. Various combinations of pin and socket contacts are used as a polarizing guide. For further information write for Bulletin LS5-1951.



SR Receptacle

SCR Plug

SCP Plug

SRB Receptacle

CANNON ELECTRIC

Since 1915

Factories in Los Angeles, Toronto, New Haven, Benton Harbor. Representatives in principal cities. Address inquiries to Cannon Electric Company, Dept. J-180, P. O. Box 75, Lincoln Heights Station, Los Angeles 31, Calif.

The Gaertner

TOOLMAKERS' MICROSCOPE

For use wherever precision measurements are required in shop inspection or layout procedures.

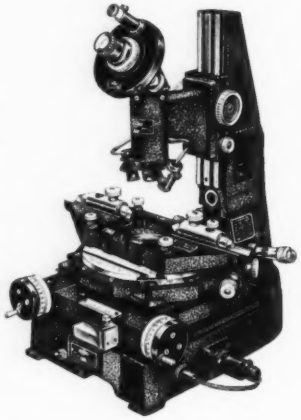
INCH OR METRIC UNITS

Coordinate Measurements
Left to Right.....100 mm or 4 inches
Front to Rear ..... 50 mm or 2 inches

Direct Reading to..0.002 mm or 0.0001 inch

Angular Measurements

Stage Range.....	360°
Reading with Vernier.....	1 min.
Protractor Circle Range.....	360°
Reading with Vernier.....	1 min.
Magnification	30X
Microscope Column Tilt.....	±8°



- **Detects errors in cutting tools.**
- **Checks threads and thread gages.**
- **Measures critical dimensions on machine and instrument parts.**
- **Adaptable to flat work, round work, odd shapes.**

A completely illustrated booklet presenting detailed information on all models and accessories and suggesting applications.

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Dept. PAS
THE HAYS CORPORATION
Michigan City, Indiana

NEW INSTRUMENTS

pH 14. Series consists of "Model ASI-400" rated at 400-500 gph. and "Model ASI-600" rated at 600-850 gph. Material of construction of pump and all fittings is stainless steel Type 316; filter assembly is made of a recently-developed synthetic resin, "Sethrin," which has extreme chemical inertness and excellent temperature resistance. Each unit comes equipped with 12-foot lengths of chemical inlet and outlet hose.—*Dept. INS, Sethco,* 70-78 *Willoughby St., Brooklyn* 1, *N. Y.*

Mention No. 1322 when filling out card.

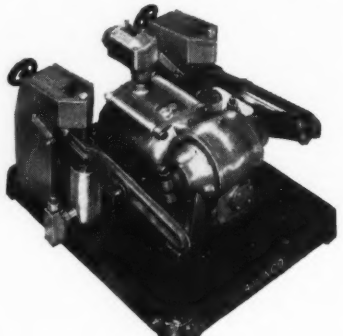
Calibrating Weights for Differential Transmitters

New calibrating weights obviate need for removing differential-pressure converters from service for checking. Equipment consists of a hanger and nine weights totaling 16 lbs. Unit weights range from 0.1 to 6 lbs. In addition to providing a convenient and economical method for making routine calibration checks, new weights determine sources of trouble in systems. New weights are intended for checking calibration only; a water column should be used if recalibration of transmitter is necessary.—*Industrial Div., Minneapolis-Honeywell Regulator Co., Philadelphia* 44, *Pa.*

Mention No. 1323 when filling out card.

Chemical Proportioning Pumps

New "Micro-Flex" chemical proportioning pumps feature displacement of all liquid in the cylinder at every stroke, with stroke adjustable while pump is



running. Other features: both stroke adjustment mechanism and legible indicating scale are stationary while pump is running; check valves can be removed easily for cleaning or replacement; powered by Class I, Group D explosion-proof motors. Piston and cylinder assemblies of stainless steel (or other alloys) for 7500, 15,000, and 30,000 psi., are readily interchangeable in same pump frame. New pumps are available in simplex style, duplex style, (each side for same maximum working pressure), and combination duplex style (each side for a different maximum working pressure).—*American Instrument Co., Inc., Silver Spring, Md.*

Mention No. 1324 when filling out card.

Makers of these and other types of instruments are listed in THE INSTRUMENTS INDEX

Dictating Machine

New "Edison VP Voicewriter" is lighter by 25 percent than any other dictating machine, and small enough to be tucked under arm or carried in a brief case. Features include a microphone which also serves as a speaker,

Vinylite "diamond disks" which have a 30-minute dictation capacity, a "4-in-1 control" knob. Machine operates on 115 v.ac. or, with a converter, in an automobile or plane; consumes 25 watts. —*Thomas A. Edison, Inc., West Orange, New Jersey.*

Mention No. 1325 when filling out card.

Corrosive-fluid Seal

New "Type 40 Isolator" separates corrosive liquids or gases from liquid-filled pressure gages and other instrumentation elements; transmits pressure

faithfully with negligible pressure drop; provides for large volumetric displacement as may result from enclosed liquid expansion; can be used at line pressures to 3000 psi. and will hold back line pressure in case of measuring-element failure. — *Trans-Sonics, Inc., Bedford Airport, Bedford, Mass.*

Mention No. 1326 when filling out card.

Automatic Program Control

New modifications of maker's time and program control systems make it possible to start and stop mechanical functions. Examples: operation of relays, solenoids or motors to sound signals, open and close ventilators, turn heating and air-conditioning systems on and off, switch light circuits on and

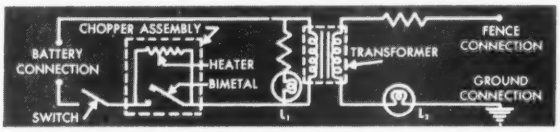
Makers of these and other types of instruments are listed in THE INSTRUMENTS INDEX

CHACE *cuts current*

3,400,000 times

IN *International's* **"FENCER"**

The International Electric Fencer Model No. 106 keeps livestock under control by supplying an intermittent electrical charge to the fence line. This is especially advantageous to farmers in protecting crops and maintaining barn control. The device known as the "chopper" contains the bimetal actuating element and is rated at 3.4 million interruptions or 2000 hours of continuous operation. The reliability of the Fencer is largely dependent upon the actuating element of Chace Thermostatic Bimetal.



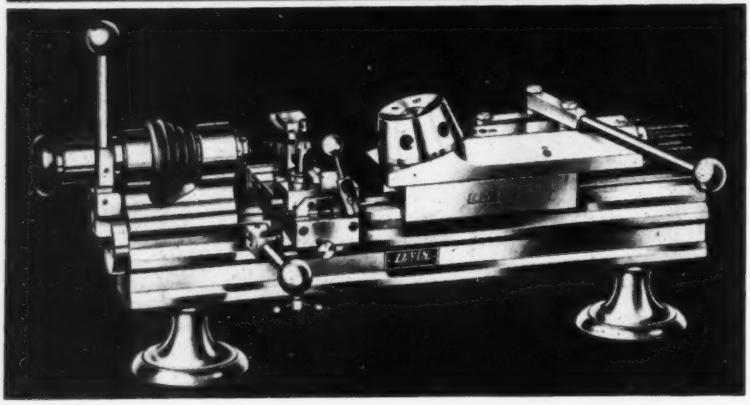
The chopper assembly consists of a straight bimetal element with contact in parallel with a resistance wire heater wound around the bimetal. Normally, the contacts are open so that initial current flows through the heater to cause the bimetal temperature to increase and move to close the contacts. This closing action shorts out the heater and decreases the temperature in the bimetal which then returns to its original open position. The current again passes through the heater to start the next operation cycle. A green light flashes during normal operation; and a red light flashes whenever the fence is grounded or the controller is shorted.

If the actuating element for your new control device is thermostatic bimetal, Chace is equipped to fabricate it ready for assembly. Our 29 types of bimetal are available in strips, coils, random long lengths and welded or brazed sub-assemblies. We invite you to consult with our Application Engineers, recognized authorities on temperature responsive devices — or write for our new 32-page booklet, "Successful Applications of Chace Themostatic Bimetal," containing condensed engineering data.

W. M. CHACE CO.
Thermostatic Bimetal
1609 BEARD AVE., DETROIT 9, MICH.

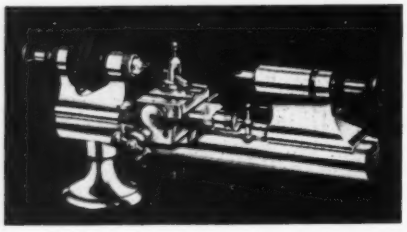
LEVIN® INTRODUCES A JEWELER'S TYPE

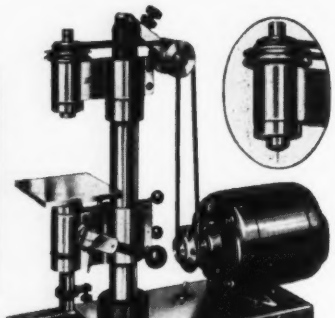
BENCH TURRET LATHE



A small sensitive turret lathe for instrument parts and second operation work. Swing 4", bed 18", collet capacity 3/16" or 5/16"; self indexing, 6 position turret with 1/2" holes and hardened slide ways.

Write for catalog listing turret lathes, turret tools and other models of lathes.





Micro-drill press for small hole drilling. Sensitive spindle holds small drills in TRUE collets ...Immediate Delivery!

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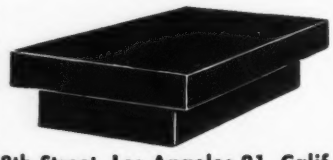
Present an absolute continuous bearing surface, finished up to 50 millionths inch. Incredibly smooth. Falling objects do not cause humps. Being harder than hardened steel, can take greatest mistreatment without causing inaccuracy of surface. No oiling. Will not rust or warp. No re-scraping. Most durable.



COLLINS MICROFLAT CO., 2326 East 8th Street, Los Angeles 21, Calif.

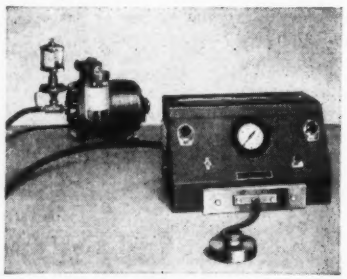
NEW INSTRUMENTS

off, etc. These can be accomplished on either a wired system or on new IBM electronic system without special wiring. Programs can be set up on a varied daily schedule as well as for inoperative periods such as week-ends.—*International Business Machines Corp.*, 590 *Madison Ave., New York 22, N. Y.*

Mention No. 1327 when filling out card.

Vacuum Tester

New Vacuum Tester can test seals, diaphragms, cylinders, bellows, pneumatic valves, manifolds, etc. Tests can be run to reveal porosity or surface



fissures, or to "prove" lapped or ground surfaces. Complete Tester comprises a vacuum pump and an instrument panel with an attached testing plate. Plate size and composition are standard, but both may be varied to meet specific testing requirements. Optional equipment also includes a remote control starter. Tester may be purchased with or without vacuum pump. A single vacuum pump will operate several test panels. Vacuum adjustment and time cycle adjustment are independent of each other. Unit comes factory preset, but can be adusted easily by user's personnel.—*Gits Bros. Mfg. Co.*, 1866 *S. Kilbourn Ave., Chicago, Ill.*

Mention No. 1328 when filling out card.

Solenoid Valves with Thermal Block

New "Types 60 and 65 Marsh-Electrimatic Solenoid Valves" are equipped with a thermal block to prevent absorption of coil heat by cold valve body,

eliminating possibility of moisture condensing in coil chamber and shorting out coil, and making valves particularly well suited for use on suction lines and cold water lines. Photo shows an

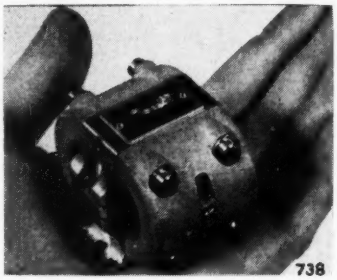
Makers of these and other types of instruments are listed in THE INSTRUMENTS INDEX

experimental arrangement of two valves mounted in suction line of a Freon 12 refrigeration system: one valve equipped with new thermal block, the other valve without. Frost was permitted to build up for several days and it was found that valve with thermal block successfully retained its coil heat and no frost formed to within ¼ in. of coil housing; while other valve showed a marked reduction in temperature and frost completely covered it.—*The Electrimatic Co., Skokie, Illinois.*

Mention No. 1329 when filling out card.

Torque Motor

New "Model 9 Torque Motor," said to be smaller and more powerful than any other now offered, is described as a precision linear actuator primarily designed to stroke pistons in hydraulic servovalves. However, it is suitable also for converting a few watts of power from an electronic amplifier to a

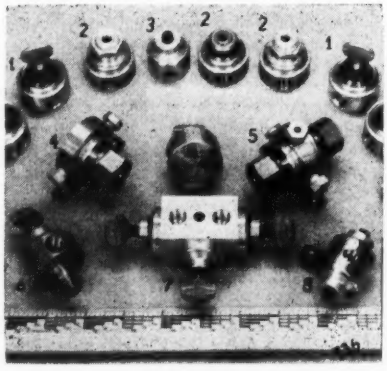


linear mechanical motion with considerable force. Midposition force, 9.5 lb.; stroke plus and minus 0.015 in.; weight, 19 oz.; no-load natural frequency, 425 cps; coil resistance, 3400 ohms (each); balance current, 20 ma.—*Midwestern Geophysical Lab., 2808 W. 40th St., Tulsa, Okla.*

Mention No. 1330 when filling out card.

Packless Valves and Manifolds

New line of packless valves and manifolds called "Demi" because of smaller-than-usual size, available with pipe (⅛ and ¼ in. IPS) or integral tubing connections (3/16 and ¼ in.) or a combination of both. Multi-ported and double ended bodies make it possible to eliminate elbows, tees, nipples and minimize space and installation cost. Valve consists of a bar stock ported body with integral seat, stainless steel diaphragm



THE LOGRINC DIGITAL GRAPH PLOTTER automatically plots one variable against another algebraically in incremental steps, in response to electrical impulses. It is ideally adapted for use as a read-out device for electronic digital computers, especially digital differential analyzers, and for use in connection with such problems as aircraft tracking and automatic data reduction.

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- can be controlled electronically or by external or remote switches or relays.
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- takes 12" x 18" paper or continuous 12" strip.

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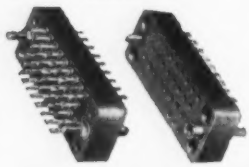
CONTINENTAL

MINIATURE *Precision* CONNECTORS

RACK TO PANEL TYPE

4 to 100 contacts



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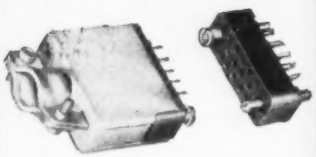
CABLE TO PANEL TYPE

4 to 100 contacts



VOLTAGE BREAKDOWN (Sea level normal humidity) ..... 3600 V. RMS
CURRENT RATING ..... 5 AMPS
CONTACT SIZE ..... 20 AWG wire
EFFECTIVE CREEPAGE ..... 1/8 in.
MECHANICAL SPACING ..... 5/64 in.

CABLE TO PANEL TYPE

Hexagonal type is provided with positive polarization and a Vibration Ring and Spring with detent locking action. Voltage breakdown at Sea level normal humidity. — 1600 V. RMS.

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45-01 NORTHERN BOULEVARD, L. I. C. 1, N. Y.

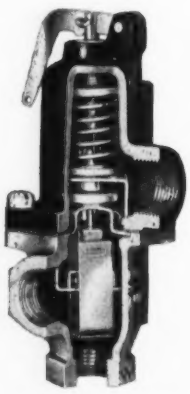
NEW INSTRUMENTS

that bears directly on integral seat and actuated by a threaded stem. Valves shown are being manufactured in brass, anodized aluminum, steel, stainless steel, Monel and nickel. Valves have been tested as high as 12,000 psi.—*George W. Dahl Co., Inc., 430 High St., Bristol, R. I.*

Mention No. 1331 when filling out card.

Combination Temperature and Pressure Relief Valves

New "202 Series" temperature and pressure relief valves, for use on hot water tanks, and heaters, offer savings in cost and installation time; are of

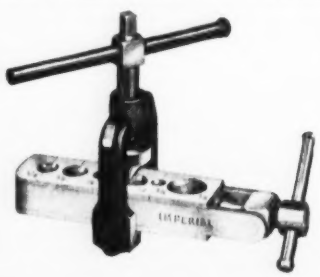


automatic reseating type. For pressure relief they utilize operating mechanism of maker's "230 Series" valves; for temperature relief they utilize operating mechanism of maker's "No. 201." New valves are available with standard opening pressure settings of 75, 100, or 125 lbs. Catalog numbers, and pressure relieving capacities: "202-75 (410,000 Btu./hr.); 202-100" (527,000 Btu/hr.); "202-125" (644,000 Btu./hr.). Temperature relieving capacity is 725,000 Btu./hr. Other pressure settings available on special order, up to 125 lbs.—*McDonnell & Miller, Inc., 3500 N. Spaulding Ave., Chicago 18, Ill.*

Mention No. 1332 when filling out card.

Flaring Tools

Two new flaring tools for making 37-degree flares on soft steel, copper, aluminum and fully-annealed stainless steel tubing are announced. Flares conform to specifications set up by Joint Industry Conference on Hydraulic

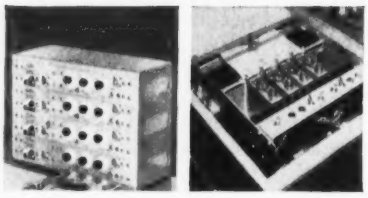


Makers of these and other types of instruments are listed in THE INSTRUMENTS INDEX

EDIN

Simplifies Your Instrumentation with this NEW *Expandable* Consolette Recorder

Start with a 2 Channel System



Add units, as you need them, to make a 4, 6 or 8 Channel System.

The Consolette gives you rack mounted dimensions with option of Direct Coupled, Condenser Coupled or Carrier Amplifiers; a wide variety of chart speeds and galvanometer types; full writing desk for review of intelligence; and an efficient, modern and beautifully designed instrument.

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Send complete information on ☐ the new Edin Consolette ☐ Recording Instruments ☐ Companion Amplifiers.

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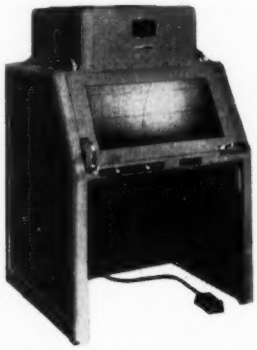
Standards for Industrial Equipment. A feature of new units is that a wide range of sizes of tubing can be flared with a single tool. "No. 437-F" flares 6 sizes of tubing from 3/16 to ⅝ in. OD; "No. 537-F" flares 4 sizes from ¾ to 1¼ in. OD and has rollers in flaring cone which facilitate flaring of larger sizes, also embodies an automatic burnishing mechanism which provides a highly-polished finish to face of flare. —*The Imperial Brass Mfg. Co., 1200 W. Harrison St., Chicago.*

Mention No. 1333 when filling out card.

COMPUTERS

Record Reader

New "Universal Telereader" measures records ranging from 16- and 35-mm. film to 12-in. oscillograph paper up to 100 ft. long; can handle either translucent or opaque records. Three interchangeable projection lenses permit record magnification of 2X, 4X, and 11X. Measuring cross-wire system is located in image plane behind ground-glass screen. Wire-transport system provides operator with coordinated means of hand motion and wire motion; screen width (24 in.) can be



traversed in about two seconds. Pulley shafts are provided with digitizing reading heads with outputs suitable for feeding to companion instruments such as maker's "Telecordex" and a summary punch so that measurements can be printed in decimal form on a typewriter and recorded into punched cards. Measuring accuracy of wire is 0.0025 in. per count; conversely, distances measured per count correspond to about 0.001 in. for 2X magnification, 0.0006 in. for 4X, and 0.0002 in. for 11X.— *Telecomputing Corp., 133 E. Santa Anita Ave., Burbank, Calif.*

Mention No. 1334 when filling out card.

Auxiliary Storage Device for Accounting Machines

New auxiliary storage device for IBM electric accounting machines makes it possible to store indicative information (such as invoice numbers or department numbers) without using counters for this purpose. Availability of counters for accumulation of totals results in greater versatility for machines. With aid of new auxiliary storage, IBM summary punch, for example, even when all counters are carrying

TIMING MOTORS

For Industrial - Military - Commercial Uses

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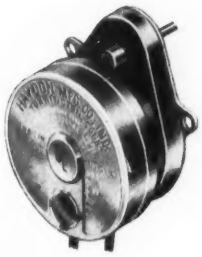
Specifically designed as a standard component for the widest possible range of timing applications with 17 standard speeds from 60 rpm to 1 revolution per hour.



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Designed for small size and low cost in applications requiring slower speeds from 6 hours to 7 days per revolution.

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STRESS measurement is simplified with the Model SG-1 unbonded resistance wire Strain Gage. It may be used repeatedly without destruction and is ready for immediate operation upon engaging its knife edge contacts to the specimen. Two active bridge arms are employed. The gage factor of approximately 2.0 permits operation with conventional existing resistance Strain Gage equipment. Two sets of knife edges provide strain measurement ranges of ±0.003 and ±0.012 In./In.

Please write the Engineering Department for data

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LABORATORIES
• Los Angeles 64, Calif.

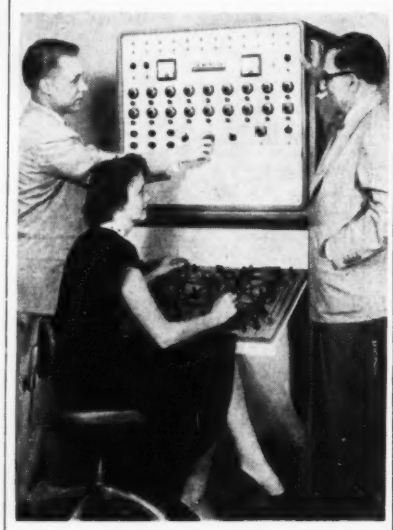
NEW INSTRUMENTS

information, still can punch either numerical or alphabetical indicative information into summary cards.—*International Business Machines Corp., 590 Madison Ave., New York 22, N. Y.*

Mention No. 1335 when filling out card.

Analog Computer

New "L3 GEDA" (Goodyear Electronic Differential Analyzer) has been used mostly for classified work under government contract, is offered as a commercial product to permit its use in a variety of fields. It is capable of solving problems of motion and control either by direct simulation or by mathematical equations. It solves problems in terms of voltages and wave forms, which are transcribed onto paper in allied recording machines, and interpreted by trained technicians. Problems of direct simulation are answered through a study of electrical and mechanical circuits. By substituting different voltages for the different parts of an equation, any problem of motion that can be translated into a mathematical equation can be solved. A removable problem board, which directly faces the operator, is easily removed for wiring purposes. Space is also provided between control panel and problem board to permit mounting various auxiliary equipment. Maintenance is simplified by use of plug-in units and by panels that swing out, up, or down, making almost all parts accessible without unsoldering or removing a single wire.—*Goodyear Aircraft Corp., Akron, Ohio.*



Mention No. 1336 when filling out card.

Self-checking Number Device for Business Machines

New Self-checking Number Device, for use on existing IBM machines, makes available a new method whereby a series of digits may be key-punched and verified simultaneously. It utilizes a "check digit," suffixed to a basic number (such as a parts number) and de-

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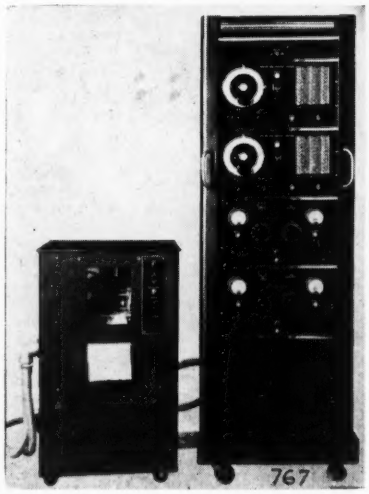
Makers of these and other types of instruments are listed in THE INSTRUMENTS INDEX

termined by a special computation of digits in original number. New device performs a calculation on basic number during punching, and compares result with check digit. If this comparison is in agreement, the number has been punched correctly. If a mistake has been made, machine suspends operation and indicates an error. Device uncovers operator errors and also provides double verification by detecting errors made in writing the source documents themselves. For new-account numbers, part numbers, etc., device enables IBM card punch to determine automatically the proper check digit and punch it into the card after operator has entered preceding digits.—*International Business Machines Corp., 590 Madison Ave., New York 22, N. Y.*

Mention No. 1337 when filling out card.

Scaler-printer for High-speed Counting

New scaler-printer designed for counting in nuclear work, packaging, etc., indicates in printed numerals up to 999; provides for multiplying this figure by 2, 4, 8, 16, 32, and 64; will resolve pulses separated by 5 microseconds; includes an interval timer for count accumulation to 55 seconds. An alternative indicator (three rows of neon lamps in decimal arrangement) works independently of printer. Instrument counts electronically, stores counts in a memory circuit, and, after completion of counting interval, channels



memorized count into a mechanical printer where part movements are minimized to assure long life: digit wheels operate independently of one another and no parts move if two consecutive counts are identical. Moreover, suppose first count is 632 and second is 635, in such case first two wheels remain motionless and third wheel merely rotates from 2 to 5. A negative input pulse of about 1 volt amplitude is required. About 200,000 such pulses per second can be handled by circuitry, but actually, with pulses having short rise times of about 1 or 2 microseconds, amplitudes as small as 0.1 volt can be counted.—*Research & Control Instruments Div., North American Philips Co., Inc., 750 South Fulton Ave., Mount Vernon, N. Y.*

Mention No. 1338 when filling out card.

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1/8 MICRO-SECOND TIMING

WHEN YOU CAN'T AFFORD TO MISS

IN MEASURING:
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- ACCELERATION
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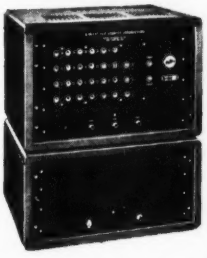
- PULSE CHARACTERISTICS

INSTRUMENT Potter COMPANY, INC.

8 MEGACYCLE COUNTER-CHRONOGRAPH

DIVIDES 1 SECOND INTO 8,000,000 PARTS



GREATER ACCURACY
The use of an 8 megacycle crystal time base provides the highest resolution of time measurement available in direct reading instruments.

COMPLETE DEPENDABILITY
To assure the highest degree of dependability, a straightforward 3-stage binary counter is used at the 8 megacycle frequency, permitting the conservative use of decade counters at the lower frequencies.

DIRECT READING
Digital registration is used to indicate time from 1 microsecond to 1 second by means of 6 Potter decades. Fractional parts of a microsecond are read from a 3-stage binary counter which indicates in steps of ⅛ microsecond.

PROVED PERFORMANCE
Ten years of service in proving grounds and research centers give conclusive evidence that the simplified circuitry inherent in the Potter Counter-Chronographs provides the maximum reliability for critical timing applications.

WIDE APPLICATION
There is a Potter Counter-Chronograph made for your specific application. . . . High-speed digital recorders are available for permanent recording of measurements at rates up to 150 per second.

WRITE FOR INFORMATION AND ENGINEERING DATA

POTTER INSTRUMENT COMPANY
INCORPORATED
121 CUTTER MILL ROAD, GREAT NECK, NEW YORK

MANUFACTURERS OF
PREDETERMINED ELECTRONIC COUNTERS • FREQUENCY TIME COUNTERS • PRESET INTERVAL GENERATORS
HIGH SPEED PRINTING AND RECORDING, SHIFT REGISTERS, AND DATA HANDLING EQUIPMENT

Take the Guesswork out of Gauging

WITH

"Varec" Fig. No. 2500

AUTOMATIC TANK GAUGE

FOR ALL TYPES OF LOW PRESSURE TANKS

Easiest To Install. Read. Operate. Maintain.

No oil tank should be considered properly equipped without a dependable, gas-tight automatic Tank Gauge! The new "VAREC" Figure No. 2500 Automatic Tank Gauge can eliminate the many errors of hand gauging and will, in addition, permit a host of time and money saving advantages.

The Fig. No. 2500 is also adapted for installation of "VAREC" Electronic Remote Reading Gauging equipment and Electronic Hi-Lo Limit or Controller Switches. Write today for full information or send coupon below!

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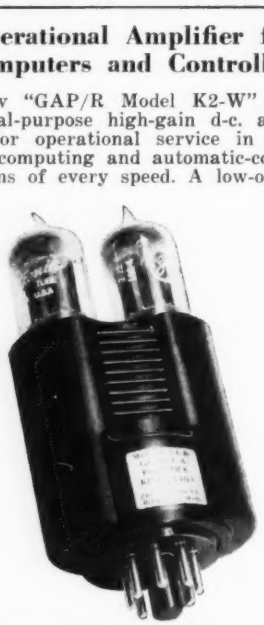
NEW INSTRUMENTS

Operational Amplifier for Computers and Controllers

New "GAP/R Model K2-W" is a general-purpose high-gain d-c. amplifier for operational service in feedback computing and automatic-control systems of every speed. A low-output



impedance is automatically maintained whether or not feedback is applied. Inputs are high-impedance and differential, permitting gains of either sign up to 15,000. Power requirements: 5 ma. at plus and minus 300 vdc., and heater power for a pair of 12AX7 double triodes. Among uses: inversion, impedance-changing, addition, subtraction, ratio-setting, integration, differentiation, and similar functions required for dynamic simulation, mathematical computation, or in actual automatic-control systems. Through a novel and compact method of assembly, ten of these amplifiers, plugged into a row of octal sockets, will fit in width of a standard relay rack.—*George A. Philbrick Researches, Inc.*, 230 *Congress St., Boston* 10, *Mass.*

Mention No. 1339 when filling out card.

D-c. Integrating Motors

New low-inertia permanent-magnet d-c. integrating motors (made in England) have linear voltage/speed characteristics through minimization or elimination of friction, iron losses,

ATLAS Damper Regulators

ATLAS makes them for all boiler room conditions.

All are hydraulically operated.

Bulletin No. 4-A—our 20-page Data and Price Book on Damper Regulators shows:

No. 501. For low pressure heating boilers.
No. 501-C. Same as above but with Compensating Attachments. Pressures from 5 to 25 pounds.
No. 501-8. For vapor and low pressure heating boilers. Atmosphere to 5 lb. pressure.
No. 502. For boiler pressures up to 150 lb.
No. 503 Cast iron base construction suitable for pressures up to 250 lb. Cast steel base construction suitable for pressures up to 400 lb.

Bulletin 4-A also explains in full what ATLAS damper regulators do and why hydraulic operation is best. Drawings show all parts and how the regulators are constructed. Drawings also show typical hook-up arrangements and regulator combinations. It is a bulletin that is worth studying, using and keeping in your files.

The coupon below will assist in obtaining Bulletin 4-A as well as data concerning other ATLAS regulating devices. We have been in the regulation business *exclusively* for more than half a century.

ATLAS VALVE COMPANY
REGULATING VALVES FOR EVERY SERVICE

292 SOUTH ST., NEWARK 5, N. J.

Represented in Principal Cities

☐ Without obligation, please send ATLAS Bulletin No. 4-A on Damper Regulators. Also please send complete information on the following ATLAS products:

☐ CAMPBELL Boiler Feed Regulators
☐ Reducing Valves
☐ Temperature Regulators
☐ Exhaust Control System
☐ Pressure Regulators
☐ Pump Governors
☐ Humidity Controllers
☐ Thermostats
☐ Balanced Valves
☐ Control Valves
☐ Oil Control Cocks

Name _____

Firm _____

Address _____

Makers of these and other types of instruments are listed in THE INSTRUMENTS INDEX

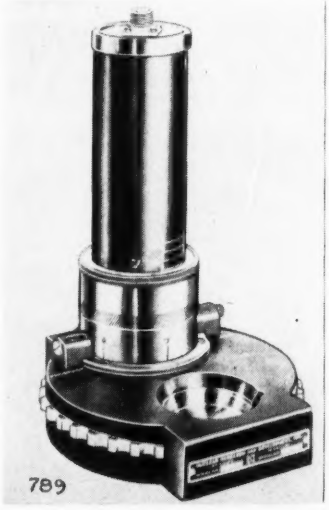
brush-contact voltage drop, etc. Resulting accuracy permits integration of feeble voltages on a time basis. Temperatures and other variables convertable into voltage signals can thus be integrated over time. Principal use: driving mechanical counters. Small sizes of these new motors can be operated directly by photocells or thermocouples. —*Masten-Wright Corp.*, 186 *Church St., New Haven, Conn.*

Mention No. 1340 when filling out card.

RADIOACTIVITY

Scintillation Counter

New "Radimax Universal" scintillation counter utilizes a single standard phototube housing which can be fitted with any of following counting heads: (1) Windowless alpha, beta, gamma rotating planchet attachment (illustrated); (2) Three-position turret head which can contain any combination of gamma, beta, alpha, or neutron phosphors; (3) Collimated medical head; (4) Standard gamma head with variable size crystals; (5) Standard beta



head with choice of anthracene or plastic phosphor. Basic unit: RCA photomultiplier, mu-metal magnetic shield, and dropping resistors. Phototube socket is spring mounted to snugly seat against crystal mounting on all attachments. Once basic unit is procured, various attachments can be added as new problems arise requiring different counting techniques: equivalent of five or six separate scintillation counters for less than total cost of separate counters.—*Nuclear Research and Development, Inc.*, 1094 *Sutter Ave., St. Louis* 5, *Mo.*

Mention No. 1341 when filling out card.

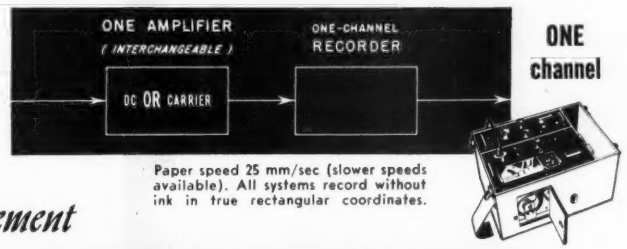
Scintillation Counter

New "Model 111 Scintillator" is a portable scintillation counter said to have 100 times sensitivity of best Geiger counter and to be ideal for prospecting, civil defense and scientific use. It can be operated from a plane or a moving vehicle. Instrument is contained in probe which weighs two pounds, is

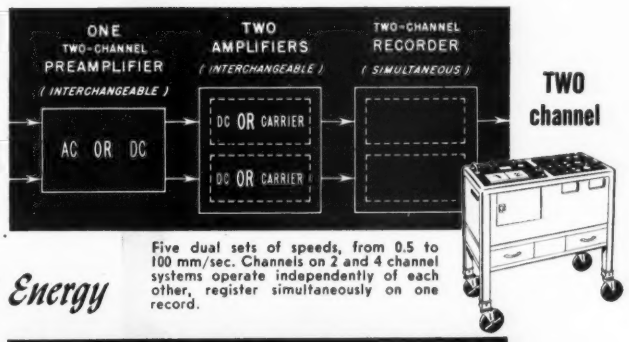
FOR DOWNRIGHT RECORDING VERSATILITY

Current
Voltage
Pressure
Temperature
Stress
Strain
RPM
Displacement
Torque
Force
Flow
Shock
Radiant Energy
Light
Tension
Load
Velocity
Vacuum
Vibration
Gas Analysis
Humidity
Acceleration
Thickness
Sound Pressure

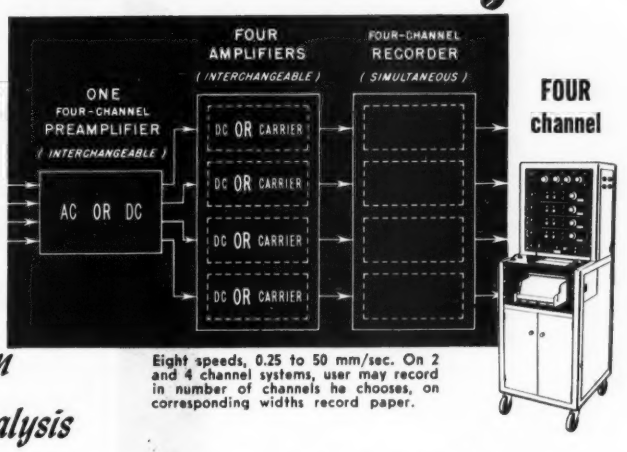
You can't beat the system WHEN IT'S A **SANBORN**



Paper speed 25 mm/sec (slower speeds available). All systems record without ink in true rectangular coordinates.

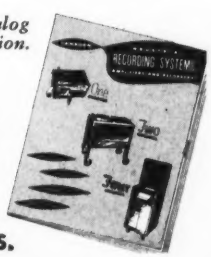


Five dual sets of speeds, from 0.5 to 100 mm/sec. Channels on 2 and 4 channel systems operate independently of each other, register simultaneously on one record.



Eight speeds, 0.25 to 50 mm/sec. On 2 and 4 channel systems, user may record in number of channels he chooses, on corresponding widths record paper.

For complete catalog address Industrial Division.



SANBORN COMPANY
CAMBRIDGE 39, MASS.

Makers of these and other types of instruments are listed in THE INSTRUMENTS INDEX

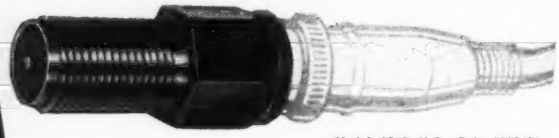
other uses

Measure acceleration and velocity. Trigger or synchronize cathode ray oscillograph sweep circuit angular position indicator (shaft or fly-wheel), reference marker (degrees, position or dead center). Indicate RPM, operations, cycles or motion at rates in excess of 20,000 per second when used with electronic counters.

ACCURATELY INDICATES

Rate of Motion at all Speeds

without physical contact or "loading"



Model 3010 U.S. Pat. 2396/03

NEW

Electro ELECTRONIC EQUIPMENT **IMPULSE GENERATOR**

Small low cost electromagnetic pick-up amplifies electrical impulses for counting recurring operations, revolutions, sequences, cycles or motions. It produces a voltage output proportional to the object's rate of speed. And may be actuated by the displacement or vibration of any magnetic material in the field of the pick-up. Such as a slot or keyway in the rim of a wheel or shaft, the teeth in a gear, or any magnetic part on a moving body.

Consult Our Engineers On Your Particular Problem.
Write for Bulletin MP 592 Today!

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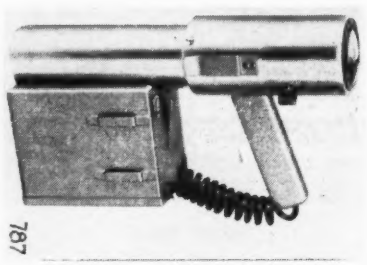
- Steel case (DC), Brass Case (AC) with copper—cadmium—dichromate finish.
- Excellent shielding due to case material and construction.
- Double strength clear glass.
- Black satin onodized aluminum bezel.
- Glass to metal seal under controlled humidity and temperature conditions.
- D'Arsonval permanent magnet type movement for DC applications.
- Magnetically damped, moving iron vane type movement for AC applications.
- Available in 1½" square, 2½" and 3½" round case types.
- Guaranteed for one year against workmanship and materials.

BURLINGTON INSTRUMENT COMPANY

Dept. H-102, Burlington, Iowa

NEW INSTRUMENTS



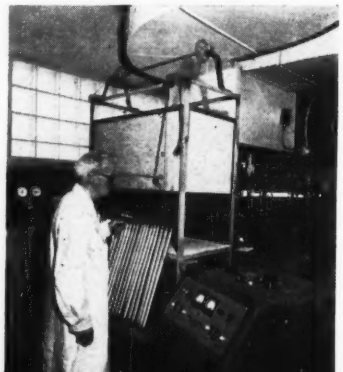
787

completely waterproof and tropicalized. Ranges are 0.05, 0.5 and 5 milliroentgens per hour and it is accurate within 5 percent of ¾ full-scale reading. Battery box, carried on belt, weighs less than four pounds. Instrument can be used by untrained persons.—*Precision Radiation Instruments*, 2235 *S. La Brea Ave., Los Angeles* 16, *Calif.*

Mention No. 1342 when filling out card.

Neutron Counter

New Boron Trifluoride Neutron Counter, said to be the most efficient commercially manufactured, is an enriched BF_3 counter of all-aluminum



construction (except for anode, Kovar seal and connector), which insures minimum neutron capture in counter shell. End sections are "heli-arc" aluminum-welded, and whole counter is helium leak-tested before filling (see illustration). It is baked at 100 C. for 12 hours while being evacuated. A guard ring type construction is utilized. Counters are available in pressures of 150 and 12 cm. Hg, and in three standard sizes: 1 x 6 in., 1 x 12 in., and 1 x 20 in. active length.—*Radiation Counter Labs., Skokie, Illinois*

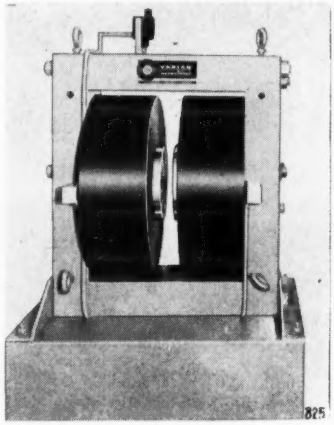
Mention No. 1343 when filling out card.

Research Electromagnet

New "Model V-4012 Research Magnet" provides magnetic fields as high as 40,000 gauss, or lower fields with extremely high uniformity. Applications include nuclear- and paramagnetic-resonance work, Zeeman studies, etc. Under standard arrangement with

Makers of these and other types of instruments are listed in THE INSTRUMENTS INDEX

pole caps of 12-in. diameter and air gap of 1.75 in. a magnetic field is produced which is uniform to one part in 50,000 throughout a cubic inch volume of air gap. Maximum air gap of 5.25



in. is possible. For high-field studies, tapered pole caps are substituted for conventional flat ones. Typical gap fields with 4-kw. input to energizing coils: 12-in. D, 5.25-in. air gap, 7000 gauss; 12-in. D, 1.75-in. air gap, 13,500 gauss; 1-in. D, 0.5-in air gap, 0.125-in. axial hole for Zeeman effect observations, 40,000 gauss. "Model V-2100 Power Supply" with extremely high regulation has been specifically designed for use with this unit as well as with a magnet of similar design but having 8-in. diam. poles.—*Varian Associates, 916 Varian St., San Carlos, Calif.*

Mention No. 1344 when filling out card.

LABORATORY

Quartz-plate X-ray Angle Identification Fixture

New "Production Quartz Plate Apparatus," for identification by x-ray diffraction of quartz-plate atomic plane relationships, is designed for rapid check of crystal plate x-ray angles on a production basis. It can be used with x-ray diffraction units currently in use and is intended for use by machines to be designed for similar application. Makers report that in their own use, apparatus has increased readings per machine per 8-hour day from 1500 to 8500.—*United States Testing Co., Inc., 1415 Park Ave., Hoboken, N. J.*

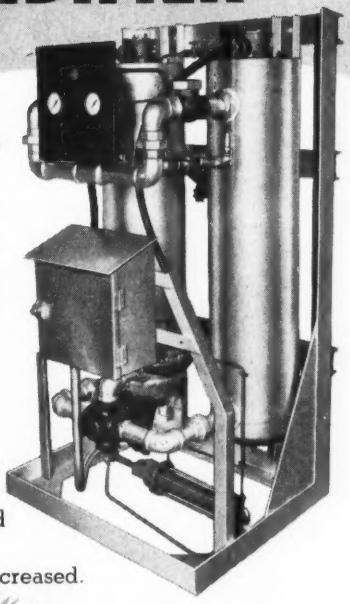
Mention No. 1345 when filling out card.

Laboratory Press

New "Model 12-12 Hydraulic Laboratory Press" provides a total available force of 60,000 lbs. Stroke 6 in.; maximum daylight opening 10 in. (longer columns can be supplied). Unusual feature of this model is distinct paralleling of platens, accomplished by precision boring of guide holes. Heating platens may be readily removed; platen area 144 sq. in.; width between columns 14 in.; height 36 in. Bimetallic type of temperature regulator and relayed load method facilitate operation at close temperature differential. Temperature indicator is a millivoltmeter

Makers of these and other types of instruments are listed in THE INSTRUMENTS INDEX

Keep Instrument Air CLEAN and DRY with an Industrol DYNAMIC DEHUMIDIFIER



Backed by years of experience, INDUSTROL Dynamic Dehumidifiers have been especially designed to provide clean, dry instrument air, at low cost. With their use a drastic reduction of instrument maintenance is made possible. Costly instruments can last longer, operate at maximum efficiency.

Perfect heat distribution built into the design of these units assures excellent regeneration. To care for future needs, units are so designed that larger chambers can be installed with minimum effort and expense, should unit capacity need to be increased.

Industrol DYNAMIC Dehumidifiers offer these advantages:

- Simplicity of design
- Ease of installation
- Superior type of desiccant —easily replaced without dismantling unit
- Minimum maintenance
- Complete dependability
- Compact, economical, rugged
- Sizes—35 - 1500 cfm.
- Perfect regeneration—steam or electric

SEND FOR — new illustrated Bulletin DD-140 describing INDUSTROL Dehumidifiers and how to size a unit to fit your requirements.

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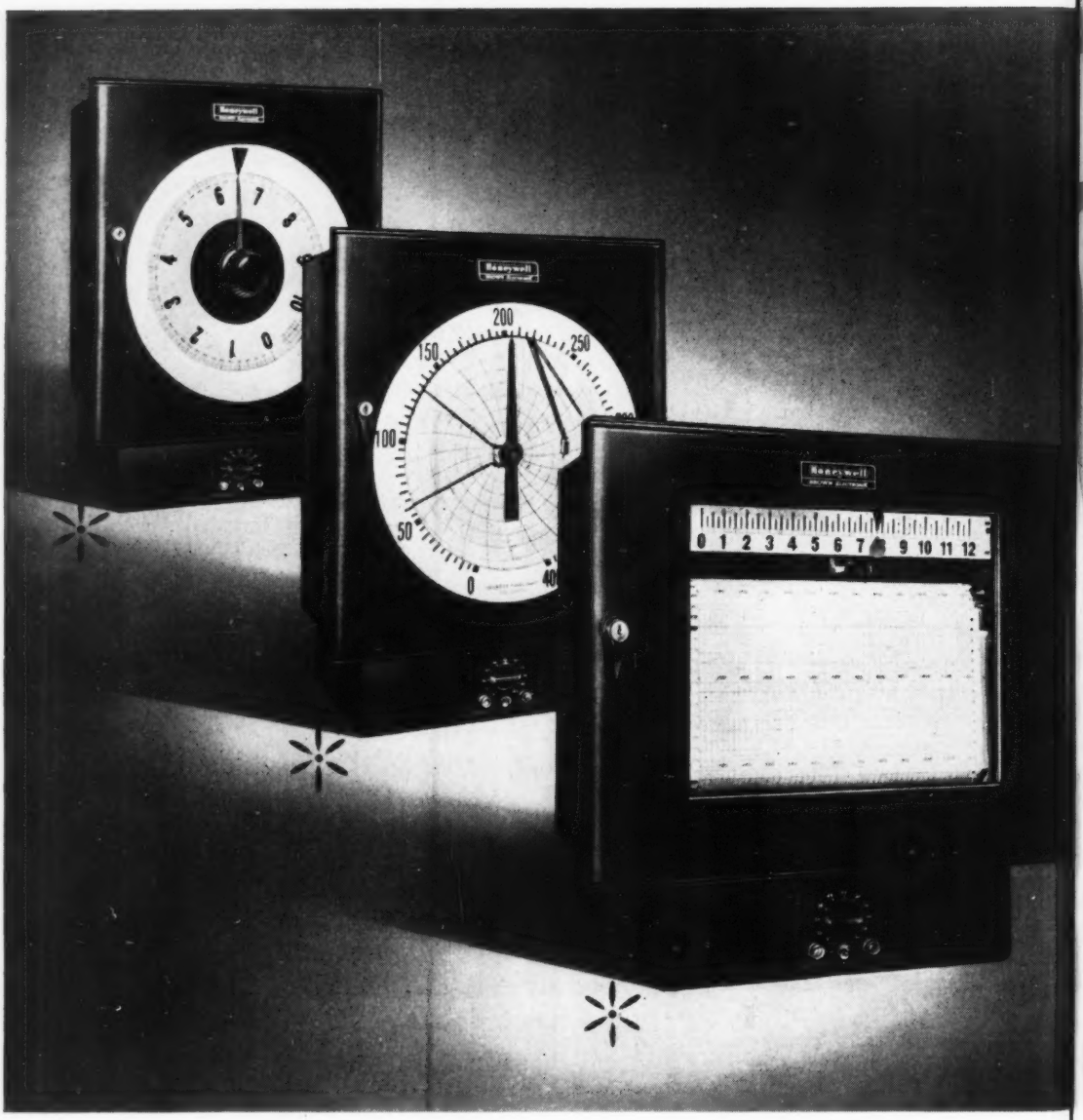
For peak performance . . .



The difference in control action lies in this relay . . . an integral part of the **ElectroniK** *Controller. Approach rate adjustment limits overshoot on batch operations.*

choose the control that suits your furnace

FOR STRAIGHT LINE TEMPERATURE RECORDS

When heat input should vary like this . . . (LIKE THIS)

...choose

Electr-O-Line

ELECTRIC PROPORTIONAL CONTROL

This position-proportioning electric control delivers continuous heat input; varies the fuel flow by throttling the valve in exact response to changes in heat demand. Both proportional and automatic reset actions are included. Proportional control makes the valve move a large amount for big temperature changes, a small amount for little temperature changes. Automatic reset takes care of variations in load, fuel supply pressure and heat content of fuel.

. . . choose Manual Reset Control *for applications where requirements are less critical. This type has the same position-proportioning action as Electr-O-Line Control, but reset must be manually operated.*

When heat input should vary like this . . .

...choose

Electr-O-Pulse

ELECTRIC PROPORTIONAL CONTROL

Many furnaces need control which supplies fuel at full input, in order to obtain specified heat distribution. For these, as well as for electric furnaces, Electr-O-Pulse Control delivers full heat input in pulses, controlling the ratio of "heat-on" to "heat-off" time to regulate average input as required. This control incorporates both proportional and reset actions. For electric furnaces, it regulates a power contactor. For fuel-fired furnaces, it operates a solenoid or motor-driven valve.

WHETHER your furnace is electric or fuel-fired, big or small, batch or continuous, Honeywell electric proportioning control will assure top quality and maximum output. Here are some outstanding plus values:

Simple installation *— the controller takes little more panel space than a recording instrument, because the control relay is an integral part of the instrument.*

Easy "tuning" *to the requirements of your individual furnace. Each control adjustment is entirely independent. Changes in one do not upset the others.*

Time-saving maintenance *— the entire relay, a compact plug-in unit, can be removed and replaced in a few seconds.*

The control instrument can be an *ElectroniK* strip chart or circular chart recorder, or circular scale indicator. Any of these instrument models can be supplied complete with Electr-O-Line, Electr-O-Pulse or Manual Reset Control. For modernizing existing installations, the control relays are available separately.

Your local Honeywell engineering representative is well qualified to recommend the type of control best suited to your furnace. Call him in today . . . he is as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4482 Wayne Ave., Philadelphia 44, Pa.

MINNEAPOLIS
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First in Controls

● *Important Reference Data*

Write for Catalog 15-15, "*ElectroniK* Potentiometers with Electric Contact and Electric Proportional Control."

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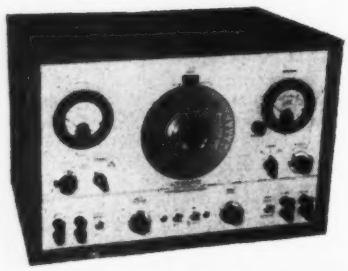
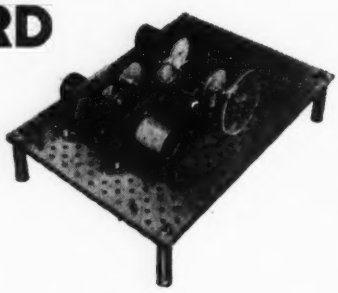


Test analyzer for use in development and PRODUCTION of SERVOMECHANISMS and PROCESS CONTROLS. Measures FREQUENCY RESPONSE, PHASE SHIFT 0.1 to 20 CYCLES SINE WAVE, SQUARE WAVE, MODULATED CARRIER, 50 to 800 CYCLES.

SERVOBOARD

A FLEXIBLE SET of PRECISION mechanical parts for quickly coupling motors, synchros, potentiometers to form assemblies of Servo systems, regulators, computors.



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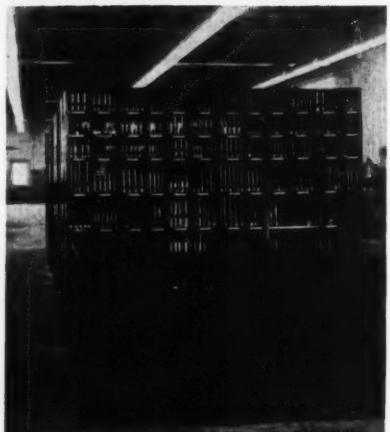

—in a wide variety of designs, sizes and materials.

We will be glad to place your name on the list to receive copies of the monthly Trinity Thermowell Stock List.

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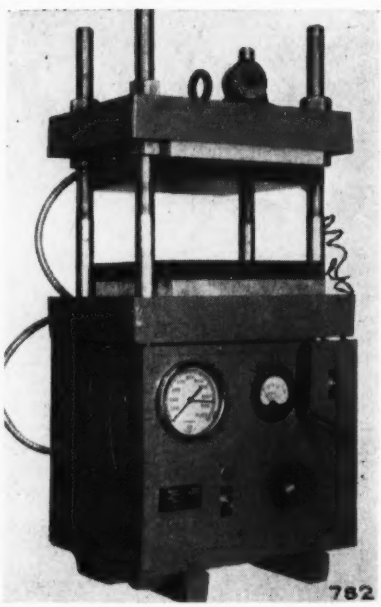
494 Westfield Ave., East Roselle Park, New Jersey
THERMOWELLS and other Specialties for the Process Industries

NEW INSTRUMENTS



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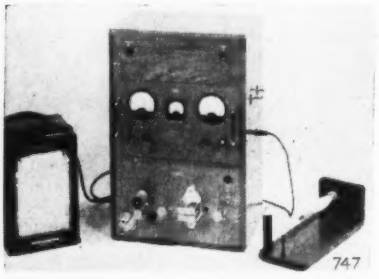
actuated by thermocouples. Mercurial thermometers may be inserted in wells provided in each platen. Control cabinet console has been enlarged to permit ready access to hydraulic unit and controls.—*Hydraulics Div. Wabash Metal Products Co., P. O. Box* 305, *Wabash, Indiana.*

Mention No. 1346 when filling out card.

Yarn Evenness Recorder and Integrator

New uniformity tester for sliver, roving, and yarn, operates on dielectric principle, using Fielden bridge circuit. A continuous record of variations in mass per centimeter is produced on (Esterline-Angus) recorder. Two integrating circuits show, on two panel



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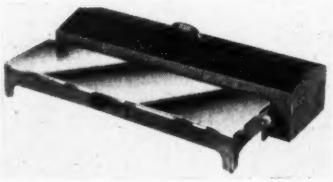
indicators: (a) mean deviation of yarn expressed as a percentage of mean weight, and (b) mean level of yarn. Four plug-in electrode heads are provided to cover materials from slivers to finest yarns up to 15 denier or equal. Two yarn traverse speeds (5 and 50 yards per minute) and 5 chart speeds (0.75 to 12 in. per minute) can be selected. — *Fielden Instrument Div., Robertshaw-Fulton Controls Co.,* 2920 *N. Fourth St., Philadelphia* 33, *Pa.*

Mention No. 1347 when filling out card.

Makers of these and other types of instruments are listed in THE INSTRUMENTS INDEX

Laboratory Hot Plate

New "Utility Warmer Plate" is thermostatically controlled from room temperature to 100 C.; one-degree sensitivity; built-in thermometer. Working



surface, 24 x 6.5 in., is uniformly heated by woven-mat-type heater guaranteed for ten years. Operates on 115 v.ac., 300 watts.—*Labline, Inc., 217 N. Desplaines St., Chicago 6, Ill.*

Mention No. 1348 when filling out card.

ELECTRICAL & ELECTRONIC

Electrical Indicating Instrument

New mirror-scale laboratory type instrument, ruggedized for field service, is available as a d-c. voltmeter, a-c. voltmeter and d-c. milliammeter. Each

instrument has 5 ranges, and a range-and-scale changer whereby selected scale only is visible. Instruments are available singly and in sets of four.—*Phaostron Co., 151 Pasadena Ave., South Pasadena, Calif.*

Mention No. 1349 when filling out card.

Pulse Generator

New "Model B-2" pulse generator, for generation of pulses of variable width, amplitude, delay, and repetition rate, with accurate control of all factors by means of helical pots, features duty factors as high as 25 percent and repetition rates as high as 100 kc.; has an internal oscillator giving rates from 10 cps. to 100 kc. in 4 decade ranges. It may be externally triggered, or used in single-pulse operation: main pulse may be delayed from 0 to 10,000 microseconds from synchronizing pulse in 5 decade ranges. Main pulse is variable in width, from 0.2 microsecond to 1,000 usec. in 4 decade ranges, has a

Makers of these and other types of instruments are listed in THE INSTRUMENTS INDEX

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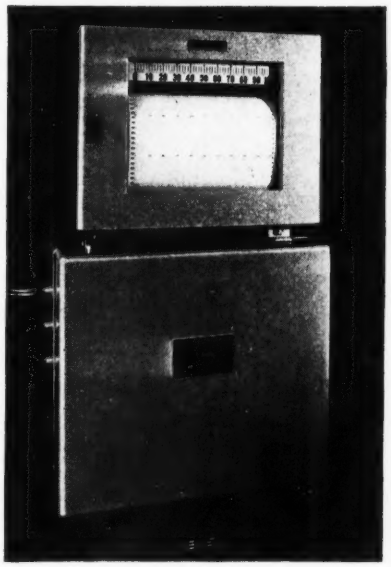
UNDER PLANT CONDITIONS



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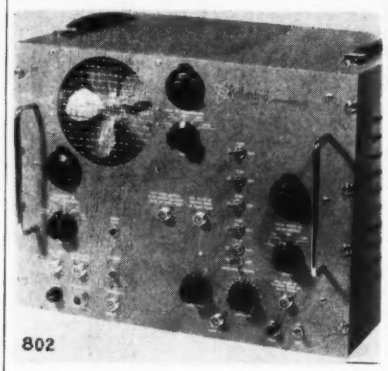
NEW INSTRUMENTS


802

rise time of 0.02 usec., a fall time of 0.05 to 0.1 usec. (depending on width), and maximum amplitude of 100 volts into an open circuit. Amplitude of outputs is adjustable. Synchronizing pulses are available at following times: 1.5 usec. before main sync pulse; main sync pulse; 1.8 usec. before leading edge of main pulse; at leading edge of main pulse; at trailing edge of main pulse (all produced by blocking oscillators). —*Rutherford Electronics Co., 3707 S. Robertson Blvd., Culver City, Calif.*

Mention No. 1350 when filling out card.

Pyrometer Millivoltmeter

New combination temperature indicating pyrometer and millivoltmeter has 8-ft. thermocouple leads and 3.75-in. mirrored scale. Three scale ranges

available, all calibrated in Fahrenheit, Centigrade and millivolts, as follows: 800 F., 430 C., 17 mv.; 1600 F., 865 C., 36 mv.; 2250 F., 1225 C., 50 mv. Automatic ambient-temperature compensation is provided. Accuracy is within 1 percent.—*Thermo Electric Mfg. Co., 496 Huff St., Dubuque, Iowa.*

Mention No. 1351 when filling out card.

Wide-band Oscillograph

New "Type 303-AH Oscillograph" is high-voltage wide-band quantitative oscilloscope for general-purpose high-frequency oscillography, with added advantage of high acceleration of electron beams. High intensifier potentials of 7,000 or 10,000 volts, or a medium potential of 3,000 volts may be selected to effect compromise between brilliancy and deflection sensitivity. High accelerating potential makes possible observation of rapid phenomena and in-

Makers of these and other types of instruments are listed in THE INSTRUMENTS INDEX

creases resolution. Pulse response 0.33 microsecond; vertical band 10 Mc.; max. linear sweep speed 10 in. per usec.; vertical deflection factor 0.1 p.-p.v. per in. Internal circuits for calibration of both time and voltage.—*Instrument Div., Allen B. Du Mont Laboratories, Inc., 1500 Main Ave., Clifton, N. J.*

Mention No. 1352 when filling out card.

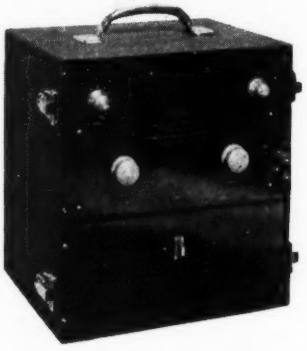
Four-channel Oscilloscope

New "Model E4GAM" high-gain four-channel oscilloscope for measuring minute potentials from brain waves, heart waves, etc., in medical research, has an unusually high maximum gain of 1,800,000. Signals from all four channels are displayed on a single 7-in. c-r. tube that may be readily photographed. Each channel is independently controlled from input through to adjustment of intensity, focus, time base, and position of each display. Sweep generator, common to all channels, has a continuously variable range from 1 sweep-per-minute to 50,000 sweeps-per-second plus provisions for blanking, external synchronization, and either common or individual positioning.—*Electronic Tube Corp., 1200 E. Mermaid Lane, Philadelphia 18, Pa.*

Mention No. 1353 when filling out card.

Low-distortion Oscillator

New "Model MB-1" battery-operated portable oscillator, designed as a source of signal power for field use, covers frequency range of 2 to 20,000 cps. in



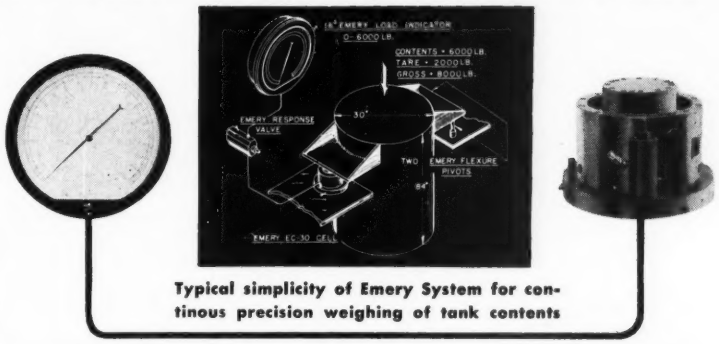
4 decade ranges. Output voltage of 5.5 volts is delivered to a 2,000-ohm load, and instrument's internal impedance is approx. 400 ohms. Distortion is less than 1 percent in audio spectrum, and dial is accurate to within 2 percent of its indication. A switch decreases battery gain when full output is not required: battery life 100 hours or more for intermittent service.—*Southwestern Industrial Electronics Co., P. O. Box 13058, Houston 19, Texas.*

Mention No. 1354 when filling out card.

Spectrum-analyzer Adapter

New "Type P-530 Spectrum Analyzer Adapter" consists of a complete set of rf. plumbing to convert any existing S or X band spectrum analyzer to frequency range centered at 35,000 Mc.; is designed for primary use from 34,000

LET EMERY SOLVE YOUR WEIGHING PROBLEM



Typical simplicity of Emery System for continous precision weighing of tank contents

HERE'S WHY . . . Emery System *completely self-contained* • *Fast response* to load changes (less than 1/2 second) • *Accuracy* within 1/10 of 1% of range • Less than *0.005-inch deflection* under full load • *No maintenance* required.

THE PROBLEM . . . Determine accurately weight of liquids frequently added and withdrawn from 6000-pound capacity tank mounted mostly below floor level.

THE SOLUTION . . . Three-point tank mounting on two Emery Flexure Pivots and one Emery EC-30 Load Cell. The dial of the 16-inch direct-reading Emery Load Indicator is calibrated to indicate precise net content of tank.

P. S. . . . Emery Response valve between load cell and indicator eliminates hydraulic surge . . . permits use of recorder or controller in addition to indicator in any Emery installation, at any distance.

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PNEUMATIC LOAD CELLS . . . with typical Emery precision and simplicity are also available for smaller loads.

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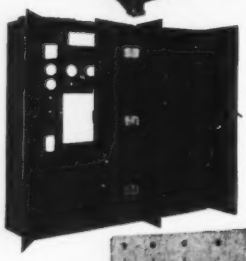

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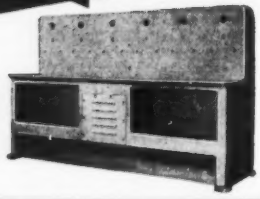

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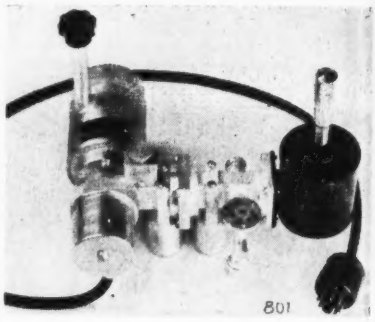


to 36,000 Mc. but will operate satisfactorily over a substantially larger range. Input sensitivity will vary with noise figure of spectrum analyzer receiver with which it is used; however, threshold sensitivities of 70 db below 1 mw. are to be expected.—*Microwave Associates, Inc., 22 Cummington St., Boston 15, Mass.*

Mention No. 1355 when filling out card.

Insulation Tester

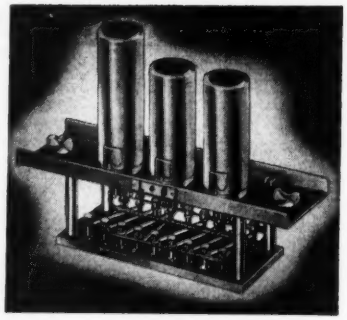
New "Model P-1 Plug-in Type Megohmer" insulation tester, for portable or bench use in production testing, has 5-in. mirror scale individually calibrated and hand-drawn; is available in single-range and double-range models. Available ranges are 100, 1000, and 2000 megohms. Self-contained power unit steps up and rectifies 115-v. 60-cps. supply to 500 and 1000 v.d.c. Guard circuit is incorporated.—*Herman H. Sticht Co., Inc., 27 Park Place, New York 7, N. Y.*

Mention No. 1356 when filling out card.

Plug-in Amplifier

New miniaturized plug-in a-c. feedback amplifier employs two pentode voltage amplifiers and a beam power output stage. Power output approx.

Makers of these and other types of instruments are listed in THE INSTRUMENTS INDEX

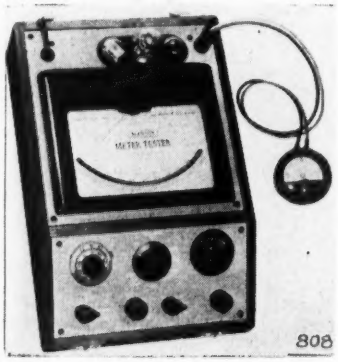


3 watts. Applications include audio and servomechanism fields, especially for driving 2-phase servomotors in systems where space is limited and ease of maintenance a necessity. Feedback resistor is connected to terminals on receptacle so that any desired gain can be achieved. Units feature sturdy and unique mechanical construction; employ JAN components; are supplied with mating receptacles; are available employing voltage or current feedback. —*L & O Research and Development Corp.*, 315 *S. 15th St., Philadelphia* 2, *Pa.*

Mention No. 1357 when filling out card.

D-c. Instrument Tester

New "Metertester Model M-2," for testing and calibration of d-c. instruments, measures sensitivity and internal resistance of sensitive instruments without exceeding full-scale ratings. Features include regulated power supply, stepless vacuum-tube voltage control, illuminated mirror-scale, bridge-



balance indication, and direct-reading bridge. Range is 25 ua. to 10 ma. full scale, and 0-100v. Over-all accuracy is better than 0.25 percent. Can be used also as a precise source of d-c. current and voltage and precision Wheatstone bridge in 0-5000 ohm range.—*Marion Electrical Instrument Co., Manchester, N. H.*

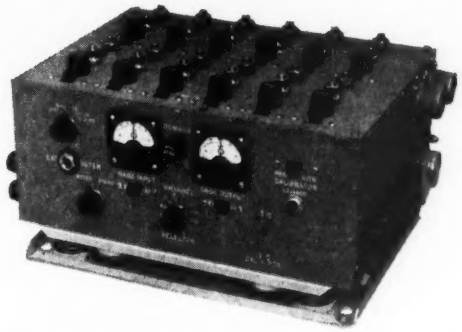
Mention No. 1358 when filling out card.

Standing-wave Detector

New "Type-1022" standing-wave detector is designed for precision low-level impedance measurements in millimeter region when used with a suitable source and amplifier. VSWR's as low as 1.01 can be read accurately in region from 34,000 to 36,000 Mc. Unit consists of a slotted section of RG-96/U waveguide milled from a solid piece of

Makers of these and other types of instruments are listed in THE INSTRUMENTS INDEX

Century MODEL 1809
BRIDGE CONTROL UNIT
FOR VIBRATION AND STRESS ANALYSIS



Designed as a companion unit to Century's famous Model 409 Oscillograph, the Model 1809 Bridge Control Unit is the latest addition to Century's line of industry-standard vibration and stress analyzing equipment. Packaged in a small, compact space, the unit contains all of the facilities necessary for use with 12 channels of resistance strain gages or bridge-type transducers. Where used with the Model 409 Oscillograph, it is necessary only to connect strain gages and power source to have a complete stress-strain measuring and recording system, small and rugged enough to be placed in an aircraft wing tip or guided missile warhead.

FEATURES:

Size: 4½" x 7" x 11".

Weight: 10½ pounds.

Aluminum case.

Up to 12 channels.

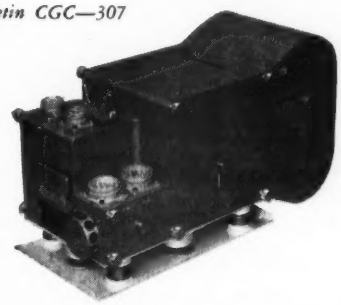
For any resistance strain gage or bridge-type transducer.

May be used with direct indicating instrument.

Power: Control unit, 22-28 Volt D.C.
Strain gage, 6-28 Volt D.C.

Write for Bulletin CGC—307

MODEL 409 OSCILLOGRAPH



The Century Model 409 Oscillograph has been designed for recording data where space and weight requirements are limited. The Oscillograph has been tested to record faithfully while subjected to accelerations up to 20 G's.

FEATURES:

Size: 5" x 6 15/16" x 11 13/16".

Weight: 13 pounds.

Cast aluminum case.

Paper speeds variable ½" to 6" and 2" to 24" per second.

Detachable daylight loading magazine with a capacity of 3⅜" x 100' paper.

2 to 14 individual channels.

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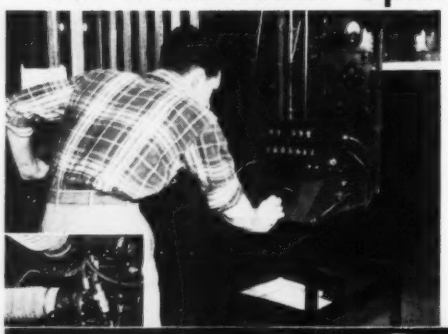

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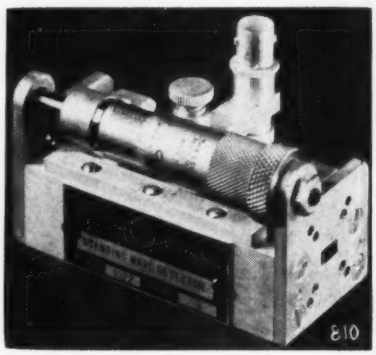
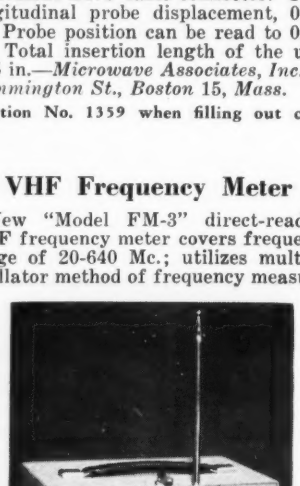


brass and silver-plated. A movable carriage, positioned by a micrometer drive, carries a spring-loaded adjustable coupling probe, a silicon diode detector socket, and coaxial output fitting which will mate with a UG-88/U or equivalent BNC cable connector. Total longitudinal probe displacement, 0.750 in. Probe position can be read to 0.001 in. Total insertion length of the unit, 3.25 in.—*Microwave Associates, Inc.*, 22 *Cummington St., Boston* 15, *Mass.*

Mention No. 1359 when filling out card.

VHF Frequency Meter

New "Model FM-3" direct-reading VHF frequency meter covers frequency range of 20-640 Mc.; utilizes multiple oscillator method of frequency measurement and includes a new "lock-in" circuit said to have unusual range, accuracy, stability and resetability. Weight is 32 lbs. with batteries.—*Gertsch Products, Inc.*, 11846 *Mississippi Ave., Los Angeles* 25, *Calif.*

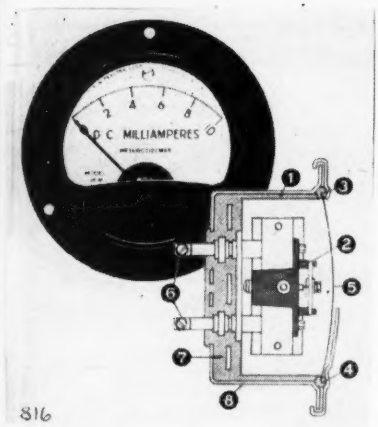


Mention No. 1360 when filling out card.

Ruggedized Electrical Indicating Instruments

New ruggedized permanent-magnet moving-coil instruments meet MIL-M-10304; withstand rough usage, shock and extremes of temperature, pressure,

Makers of these and other types of instruments are listed in THE INSTRUMENTS INDEX

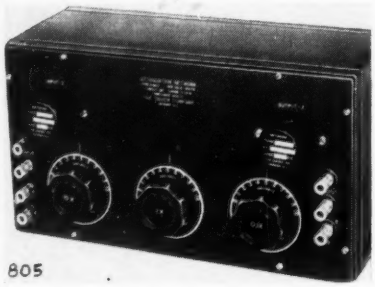


etc. Features include (1) movement shock-mounted and housed in rubber-lined case, (2) window rubber grommeted and sealed to provide hermetic seal of high-dielectric materials. Available as d-c. voltmeters, ammeters, milliammeters, microammeters, and rectifier-type a-c. instruments.—*Sun Electric Corp.*, 6323 *Avondale Ave., Chicago* 31, *Ill.*

Mention No. 1361 when filling out card.

Attenuation Networks

New "Series 690" "T" or balanced "H" attenuation networks, for use in general laboratory and production testing, have a frequency range from zero to 50,000 cps.; consist of plug-in impedance-adjusting networks with either two or three attenuation controls, depending upon loss per step desired. Impedance-matching networks may be obtained in a wide range of impedance and loss. Level of operation is plus 20 db (0.6 watts) maximum input, with 1-percent accuracy resistor units. —*Dep't AN, Daven Co.*, 191 *Central Ave., Newark* 4, *N. J.*



Mention No. 1362 when filling out card.

Cathode-ray Chronograph

New "Model H-91 Recurrent-sweep Chronograph" measures time intervals between 1 and 95 milliseconds; is particularly useful for ballistic research. Uses a temperature-controlled, 1000-cycle tuning fork to drive scanning generators and to produce time-pip markers. Accuracy of measurement is approximately ±10 microseconds. In operation, two incoming signals are displayed on a horizontal ten-line raster. A second coincident raster consists of vertical lines separated by one

Makers of these and other types of instruments are listed in THE INSTRUMENTS INDEX

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Anything less than 100% safe is 100% UNsafe.

This fellow's lucky, in a way. He *thought* his safety valves were 100% safe, and because they weren't, they might have killed him. Because those valves were *almost* safe, it's going to cost someone a lot of money.

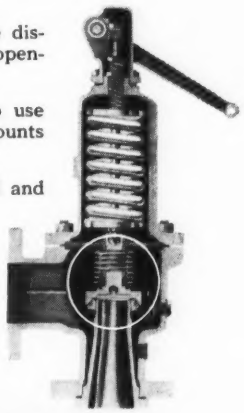
There's only one way to think of safety—think in terms of 100% or nothing. There's one sure way to *get* 100% safety—specify BalanSeal or FarriSeal Valves.

Why? Because they *can't* stick, plug or corrode. Critical working parts are permanently isolated from any contact whatever with the lading.

Because they're unaffected by back pressures in the discharge manifold due to its own operation or to the opening of other valves in the line.

Because these features make it possible for you to use smaller discharge piping, an economy which often amounts to substantially more than the cost of the valves.

You'll be interested in the engineering of BalanSeal and FarriSeal Valves—design which is rapidly gaining acceptance in hundreds of successful installations.



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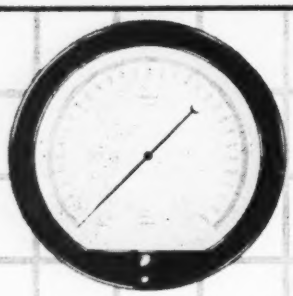

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of extreme accuracy

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- √ Revolving dial zero adjustment
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For the unusual pressure gauge application — where extreme accuracy and stability under continuous-use or other exacting conditions are essential — Heise Gauges can be specified with confidence.

Manufactured on special order only in ranges from 0-15 to 0-10,000 psi. Sizes: 8½", 12" and 16". Prices: $151.60 to $211.20. Write for catalog.

Heise Bourdon Tube Company, Inc.
Newtown, Connecticut

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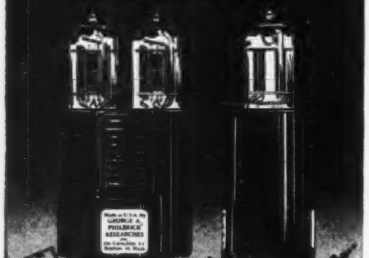
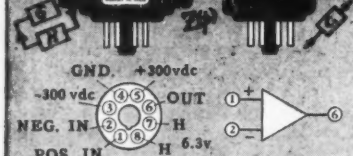
Operational Amplifier

GAP/R MODEL K2-W





SPECIFICATIONS

USAGES: Feedback Computors, dynamic synthesizers, simulators, buffer amplifiers, followers, etc., etc.
VOLTAGE GAIN: 10,000 plus.
INPUTS: Differential pair. Resistance of each is 10 megohms plus.
OUTPUTS: Impedance is 300 ohms, up to 1 milliampere and to 50 volts plus or minus.
RESPONSE: Repetitive or discrete. Aperiodic from DC up to 2 microseconds rise time under full feedback.
POWER: Total consumption 6½ watts.
TUBES: 2 12AX7. PLUG: Octal.
SEATED HEIGHT: 4 ins. WEIGHT: 2.8 oz.
UNIT PRICE: $42.40 Complete, Postpaid in USA.

George A. Philbrick Researches, Inc.
230 Congress Street, Boston 10, Mass.

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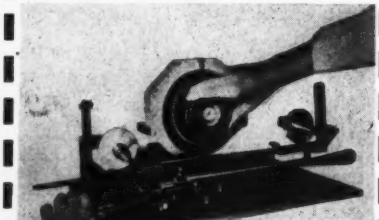

STAMPS INDIVIDUAL LETTERS AND NUMBERS IN PERFECT ALIGNMENT AND IN COLOR ON PAINTED OR BAKED ENAMELED METALS, PLASTICS, WOOD, PAPER AND OTHER MATERIALS.

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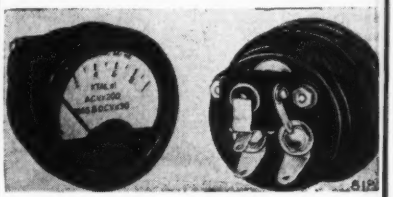
NEW INSTRUMENTS

millisecond. Camera alternately records each raster on same film so that two rasters are superimposed in resulting picture. Interval between vertical lines then gives measurement of time interval between signal pulses.—*Electronic Tube Corp.*, 1200 *E. Mermaid Lane, Phila.* 18, *Penna.*

Mention No. 1363 when filling out card.

Illuminated Instruments

New "Model 150" is 1.5-inch illuminated panel instrument in round case; "Model 153" has square case. Lamp housing is external. Permanent-magnet moving-coil movement has sealed "peep" window in rear of case. Light admitted through window is diffused



through a translucent plastic scale. Lamp is supplied for 6, 14, and 28 volts. Instruments meet government specifications for watertight sealing.—*International Instruments, Inc., P. O. Box 2954, New Haven 15, Conn.*

Mention No. 1364 when filling out card.

Selenium-rectifier Tester

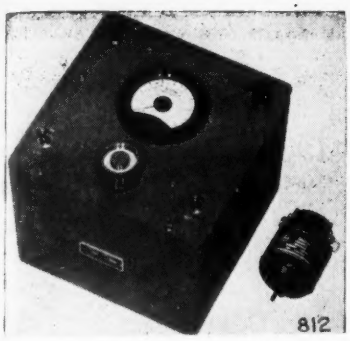
New "Galvanic Selectester, Model 100A" is said to be first self-contained instrument designed specifically for testing selenium rectifiers by detecting

and evaluation forward resistance, reverse leakage current, opens, and shorts. Weight is 6 pounds.—*Rectifier Div., Galvanic Products Corp.*, 110 *E. Hawthorne Ave., Valley Stream, N. Y.*

Mention No. 1365 when filling out card.

Wide-range Motor Control

New "302-A" wide-range speed and torque generator consists of a motor and control box operating from 117-v. 60-cps. line. Motor speed can be varied from 100 to 10,000 rpm.; with max. output torque of 1.0 oz.-in. Matching gear boxes available for any reduction



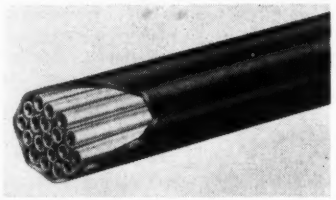
ratio. Motor speed can be controlled remotely, either by a varying d-c. voltage or a shaft position. Speed is indicated on panel; provisions are made to measure torque delivered to load. Among application; automatic-control systems, industrial process control, servo directors, variable-speed turntables and textile looms.—*Industrial Control Co., Wyandanch, L. I., N. Y.*

Mention No. 1366 when filling out card.

SHOP EQUIPMENT

Instrument-tubing Harness

New "Dekoron Impervapak Metl-Cor" corrosion-proof instrument-tubing harness is composed of a bundle of copper or aluminum tubes over which is extruded a 1/16-in. thick sheath of high-molecular-weight black polyethylene plastic; is said to have lower initial cost than corrosion-resistant alloy tubing, to cost less to install than individual instrument lines, and to conserve critical materials. It is available in lengths up to 50 feet, with 4, 7, or 10 metal tubes of ¼ or ⅜ in. OD. (Other sizes on special order.) Successive 50-ft. lengths are joined by standard pressure-tight fittings.—*Dekoron Tubing Div., Samuel Moore & Co., Mantua, Ohio.*



Mention No. 1367 when filling out card.

Screw-cover Head for TC's and Resistance Bulbs

New screw-cover head, for use against weather and corrosion wherever protection is required for terminal connections of thermocouples and high-speed resistance-thermometer bulbs, is made of cast iron, is zinc-plated, and is coated with zinc enamel. Cover has slots that facilitate assembly with a screw-driver shaft or a wrench. To prevent rusting, threads are on inside of base, and outside of cover is zinc-plated and coated with aluminum enamel after threads are machined. Hexagonal protecting tube and conduit outlets fit

CUBIC'S 3 SIDED COVERAGE

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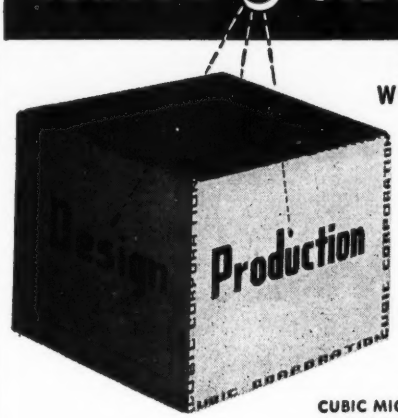


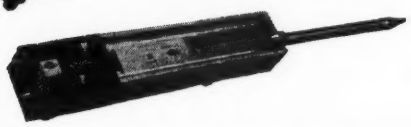
• MICROWAVE & RADAR COMPONENTS
• ELECTRONIC INSTRUMENTS & TEST EQUIPMENT

CUBIC MICROWAVE ENGINEERS—specialists in the field since the inception of Radar in World War II—start with electronic problems and ideas, and convert them into the most accurate precision-built electronic instruments and equipment! We welcome inquiries—not only in connection with our rapidly developing list of products—as represented below—but on ideas, problems, or design of microwave assemblies of your own specification you may want developed and produced.

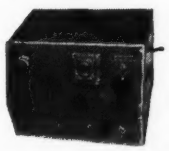
MICROWAVE CALORIMETRIC WATTMETER

portable . . . for lab and field use . . . to measure absolute microwave power.
Frequency Range: 2600 MC to 26500 MC
Max. VSWR: 1.1
Max. Peak Power: 600 KW

COAXIAL CALORIMETRIC WATTMETER



Frequency Range: 200 MC to 3000 MC—Max. VSWR: 1.5 over range—Max. Peak Power: 1⅝" Coaxial rating

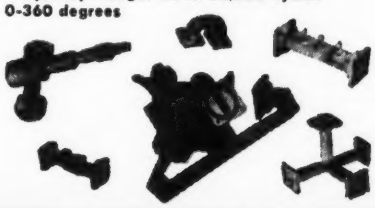


MICROWAVE (X-BAND) PULSE MEASURING WATTMETER

for measuring peak power of microwave pulses from signal generators or radar systems.

ELECTRONIC DIRECT-READING PHASE METER

Frequency Range: 20 to 50,000 cycles
0-360 degrees



Shown at left are a few of our standard microwave components available as catalog items. Special purpose wave guide assemblies designed to customer's specs can also be produced.

CUBIC CORPORATION

Makers of these and other types of instruments are listed in THE INSTRUMENTS INDEX

Pneumatic Weight Transmitters

FOR LINEAR CONVERSION OF WEIGHT INTO POUNDS PER SQUARE INCH AIR PRESSURE

A complete line of weight transmitters in single and multiple diaphragm construction with load capacities up to 23,000 pounds per diaphragm. Pneumatic tare balance for any portion of the total load on all models. All moving parts are enclosed totally. Complete weighing systems designed to your requirements.

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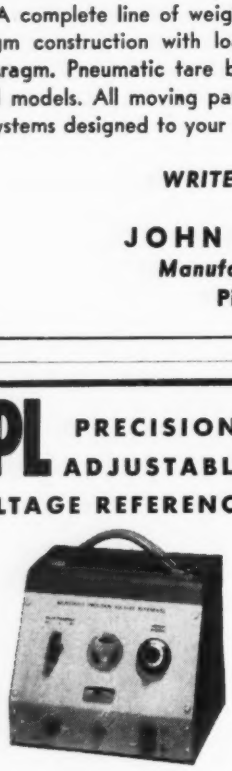
JOHN R. MONSELL
Manufacturing Engineer
Pitman, N. J.

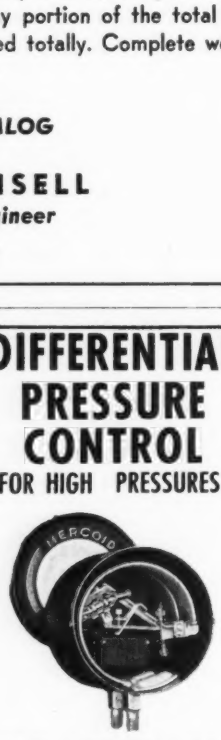
GPL PRECISION ADJUSTABLE VOLTAGE REFERENCE



This GPL all-electronic "secondary standard cell" operates from AC mains to provide a continuously variable DC supply from 0.0001 to 10 volts, with 0.1% of full-scale accuracy. Designed to work with high impedance devices – for DC amplifier testing, calibration of DC oscilloscopes and V-T voltmeters, determination of vacuum tube characteristics, voltage comparison by null detection method. Immune to short circuit damage. Immediate delivery.

GPL GENERAL PRECISION LABORATORY
63 Bedford Road, Pleasantville, N.Y.

DIFFERENTIAL PRESSURE CONTROL FOR HIGH PRESSURES



Mercoid Type BB Differential Pressure Controls open or close a switch contact according to a change in the difference between two pressures.

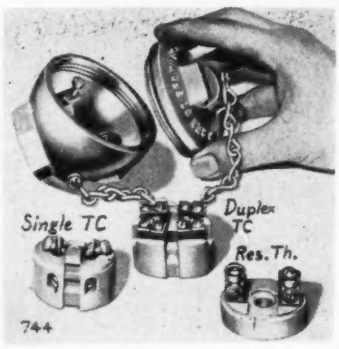
Type BB employs two Bourdon tubes, each responsive to a pressure condition to operate a Mercoid Magnet operated mercury switch as the difference in pressure between them increases or decreases. Available in ranges 60 p.s.i. to 2,500 p.s.i.

Electrical Capacity—A. C. 115V., 5Amp., 230V., 2Amp., D. C. 115V., 2.5Amp., 230V., 1Amp.

WRITE FOR BULLETIN CA-6DP

THE MERCOID CORPORATION
4205 BELMONT AVE., CHICAGO, ILL., U. S. A.

NEW INSTRUMENTS

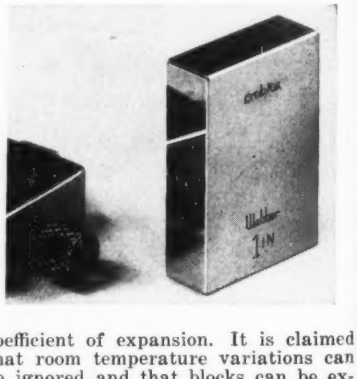


standard open-end wrenches. Single and duplex TC terminal blocks are molded of heat-resistant refractory material. Raised characters identify TC polarity and type.—*Industrial Div., Minneapolis-Honeywell Regulator Co., Philadelphia 44, Penna.*

Mention No. 1368 when filling out card.

Carbide Gage Blocks

New "Croblox" is a new type of carbide gage block: made of chrome carbide, which has superior corrosion resistance, plus similarity to steel in



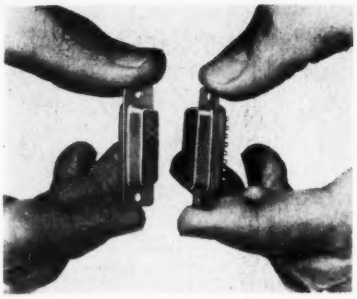
coefficient of expansion. It is claimed that room temperature variations can be ignored and that blocks can be exposed to a wide range of atmospheric changes without trace of rust. Wear resistance is exceptionally high and a surface finish of 0.1 microinch is attainable. 2-in., 3-in. and 4-in. blocks are provided with Bakelite finger grips to shield blocks from body heat.—*Webber Gage Co., 12904 Triskett Rd., Cleveland 11, Ohio.*

Mention No. 1369 when filling out card.

COMPONENTS

Miniature Connectors

New "Series D" multi-contact connectors comprises four miniature connectors with from 15 contacts to 50; smallest having over-all length of 1 17/32 in., depth 31/64 in. and width 27/64 in. plus a solder-pot extension of 9/64 in. Steel shell provides strength comparable to standard aluminum shells

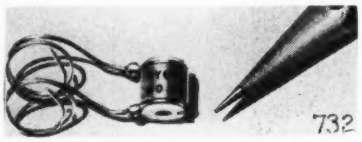


and yet maintains a lighter weight. Nylon insulator makes possible high dielectric qualities for gold-plated 5-amp. contacts.—*Cannon Electric Co., 420 W. Ave. 33, Los Angeles 31, Calif.*

Mention No. 1370 when filling out card.

Precision Resistors

New "Series E" fixed noninductive wire-wound resistors have extremely low temperature coefficients, units under 800 ohms being wound with Manganin wire and those over 800 ohms with Evanohm wire. Resistors wound with alloys having special temperature co-



efficients are available on request. Available resistance values, 0.1 ohm to 1 megohm. Standard tolerance 1 percent; 0.5 and 0.1 percent tolerances available at higher prices.—*Hycor Co., Inc., 11423 Vanowen St., N. Hollywood, Calif.*

Mention No. 1371 when filling out card.

Noncorrosive-joint Resistors

New axial-lead resistors feature noncorrosive joints without use of solders or fluxes; are said to cut production costs; are protected from chassis or

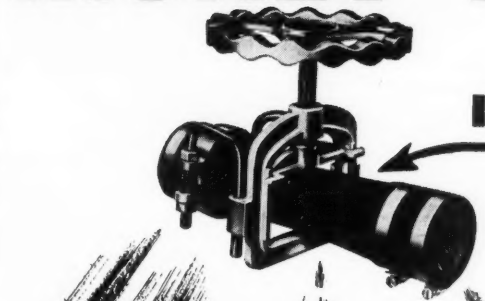
mounting surface; exceed requirements for JAN R-B-51. Made to all standard tolerances and are wound in a wide range of alloys to customers' specifications.—*Bond Electronics Corp., Springfield, N. J.*

Mention No. 1372 when filling out card.

Porcelain Capacitors

New series of monolithic-porcelain miniature capacitors covers full range from 0.5 to 2000 uuf, in both 250-vdcw and 500-vdcw ratings, in only three body types. Units are as small as 0.24 x 0.40 x 0.25 in.; are said to offer the best characteristics per unit-volume of any now available. Silver electrodes are fused into a rock-like mass of porcelain which forms both dielectric and encasing insulation. Stability is indicated by absolute retrace

YOUR MONEY BACK



IF IT PLUGS

Basically, the Flex-Valve is just a piece of flexible tubing and a clamp to squeeze it shut. It can no more clog than a length of pipe. So, if you can clog one of them in normal service, just tell us, for the "incredible-but-true" record, how in the world you did it, and we'll send your money back.

Flex-Valves have solved thousands of valving headaches —in as many plants as there have been installations made. They can handle anything that flows, including aerated or fluidized solids. They close bubble-tight over 1/8" solids. Open, the flow is straight-in-line with the service piping, and completely unobstructed. There are no moving parts in contact with the lading fluid. Available in both natural and synthetic materials for every corrosive or abrasive service.

Complete details on this unique principle of control valving in slip-on, flanged, and air-motor operated types are available on request. Ask for **Bulletin 500***—without obligation, of course.*

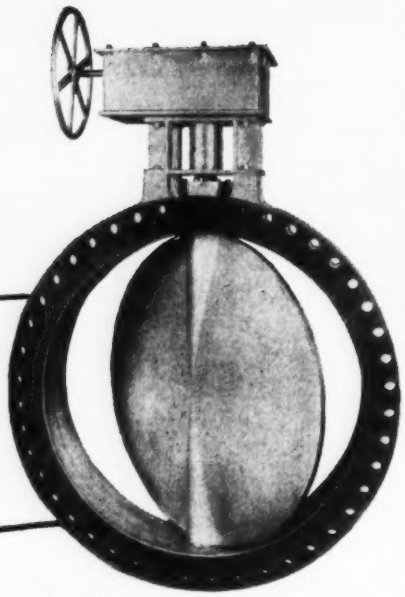
Farris FLEXIBLE VALVE CORP.

610 COMMERCIAL AVE. • PALISADES PARK, N. J.

1192

Get
Free Flow
Quick Control
Tight Shut-Off

W. S. ROCKWELL
BUTTERFLY VALVES



★ Minimum pressure drop—when fully open, valve practically as free as pipe itself.
★ Uniform, quick control manually or automatically.
★ Positive shutoff—commercial, drip tight or air tight.
★ Pressures to 600 p.s.i. Temperatures to 2000° F.
★ Made of any metal or rubber lined.
★ Sizes—1" to 72" and larger.

W. S. Rockwell 54" heavy duty butterfly valve; for 50 p.s.i.; with geared handwheel operator. May be equipped for electric, pneumatic or air operator control.

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HIGH VACUUM COATING
At LOWER Costs to You
With HIGHER Standards of Quality

LENSES, PRISMS, SPECIALIZED OPTICAL SYSTEMS

FIRST SURFACE AND PARTIAL MIRRORS
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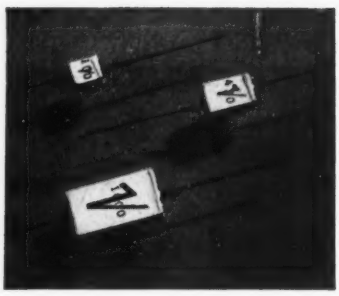
NEW INSTRUMENTS

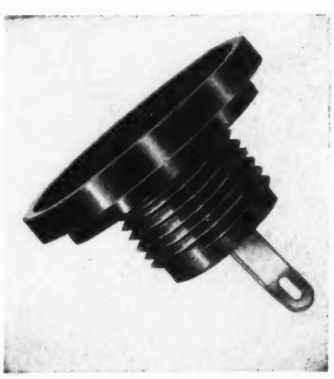


over a range greater than from minus 50C. to 200C.—*Vitraom, Inc., Box* 544, *Bridgeport* 1, *Conn.*

Mention No. 1373 when filling out card.

Nylon-base Capacitors

New "Type No. 1830AL" nylon base for use in metal-can capacitors of CP40 style under JAN-C-25 specs. has improved insulation resistance, fungus resistance, and reduced likelihood of turning within can. Heat distortion temperature at 66 psi. is 400 F.—*Industrial Devices, Inc., Edgewater, N. J.*



Mention No. 1374 when filling out card.

Molded Capacitors

New "Types CAS" low-value molded capacitor, of same size as IRC "Type BTS" resistor, is designed to obtain small values of capacitance with exceptionally high "Q". Available in standard values from 0.22 to 2.2 uuf. Molded in thermosetting material; meets JAN C-20A in temperature coefficient and humidity.—*International Resistance Co.*, 401 *N. Broad St., Phila.* 8, *Penna.*

Mention No. 1375 when filling out card.

Ceramic Disk Capacitors

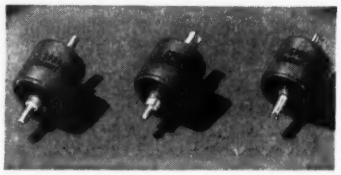
Twenty-five new critical capacitance values of standard ceramic disk capacitors enable maker to offer 40 numbers instead of original 15, to and through jobbing trade. Expanded listings now range from 0.00001 to 0.01 mfd. for single-section units; from 0.001 to 0.004

mfd. for two-section units; and 0.0015 and 0.002 for three-section units.—*Aerovox Corp., New Bedford, Mass.*

Mention No. 1376 when filling out card.

Ceramic Capacitors

New "Type 700C" high-voltage ceramic capacitors are molded in moisture-resistant, non-flammable thermosetting plastic, rated at 20,000 v. d.c.,



and designed for 85C. operation. Standard rated capacitance is 500 uuf. Terminal combinations available to meet any mounting requirement.—*Sprague Electric Co.*, 199 *Marshall St., North Adams, Mass.*

Mention No. 1377 when filling out card.

Subminiature Capacitors

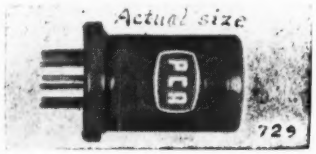
New "Type AQ" subminiature paper capacitors, for 125C. operation without derating, are available in values from 0.0047 to 1 uf.; standard tolerance

minus 15 and plus 25 percent. Glass-to-metal seal terminals assure hermetic sealing. Units may be obtained with one lead grounded to case, or insulated section construction "Type AQF."—*Astron Corp.*, 255 *Grant Ave., East Newark, N. J.*

Mention No. 1378 when filling out card.

Plug-in Pulse Transformers

New "PH" series seven-pin miniature hermetically-sealed plug-in pulse transformers pass MIL-T-27 specs; have identical electrical characteristics to



original "MPT" series; are available with pulse widths from 0.1 to 16 microseconds when used in standard PCA circuit.—*PCA Inc.*, 6368 *De Longpre Ave., Hollywood* 28, *Calif.*

Mention No. 1379 when filling out card.

Pulse Transformers for Etched Circuits

New "H" series miniature hermetically-sealed pulse transformers pass MIL-T-27 specs; are intended for use in blocking oscillator and other pulse circuits, have identical electrical characteristics to "MPT" series; are avail-

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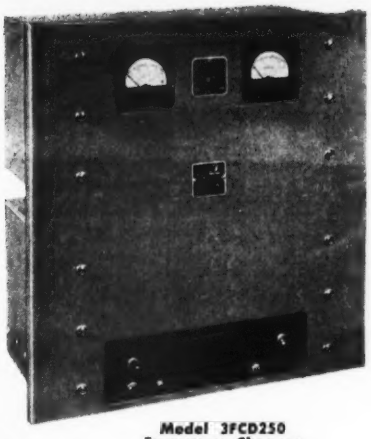

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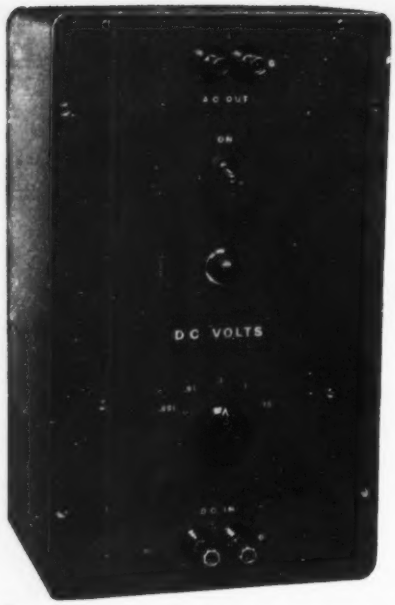

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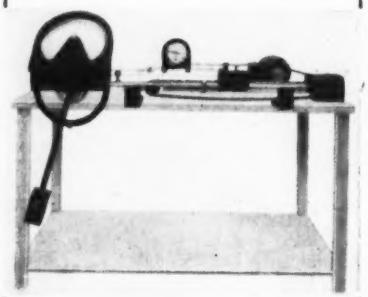

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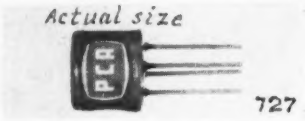

able with pulse widths from 0.1 to 16 microseconds when used in standard PCA circuit. Although designed for etched-circuit applications, they are usable in conventional wired assemblies.—*PCA Inc., 6368 De Longpre Ave., Hollywood 28, Calif.*

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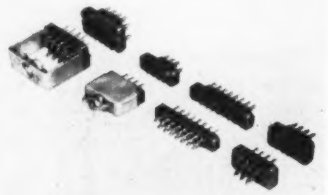

rotating contacts, mineral-filled melamine body, high dielectric and mechanical strength, creepage between contacts of 7/32 in. and breakdown voltage of 5500 v. rms. at sea level and normal conditions. Plugs and receptables are available in 7, 10, 15, 18 contacts.—*Industrial Sales Div., DeJur Amsco Corp., 4501 Northern Blvd., Long Island City, N. Y.*

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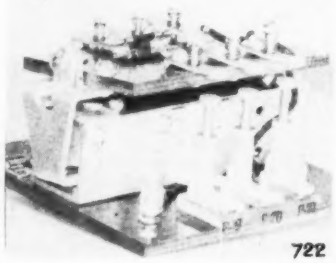

latched. Action is through a single solenoid with integral control contacts, permitting circuit connections equivalent to a two-coil unit. Relays are available in any combination of initially N-O and N-C poles.—*Automatic Switch Co., 391 Lakeside Avenue, Orange, N. J.*

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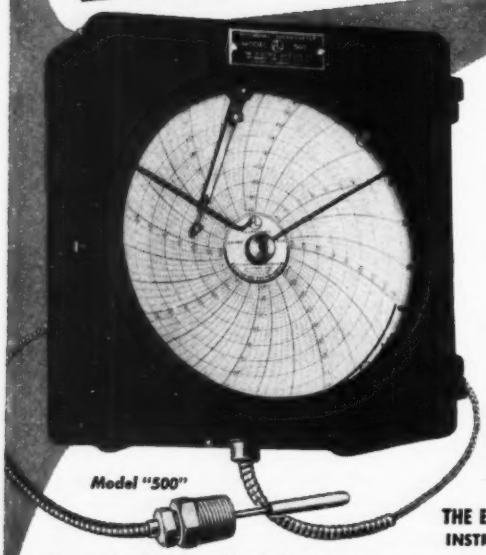

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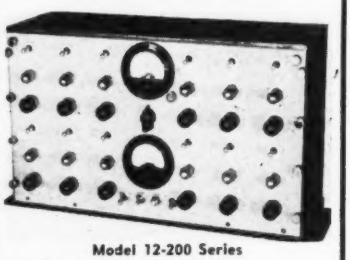

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INSTRUMENT EVENTS
Calendar

Nov. 5-8

Scientific Apparatus Makers Association. Midyear Meeting of Industrial Instrument, Laboratory Apparatus, Laboratory Equipment, Optical, Aeronautical, and Military Instruments Sections. The Homestead, Hot Springs, Va.

Nov. 6-7

Tenth Annual Pittsburgh Diffraction Conference, Mellon Institute of Industrial Research, Pittsburgh, Pa. For information write E. E. Wicker, c/o U. S. Steel Co., 234 Atwood St., Pittsburgh 13, Penna.

Nov. 6-8

1952 Annual Meeting of Electron Microscope Society of America, Statler Hotel, Cleveland, Ohio. For information write Carl E. Willoughby, Program Chairman, Chemical Dep't Du Pont Experimental Sta., Wilmington 98, Del.

Nov. 17-18

AIEE Technical Conference on Electrically-operated Recording and Controlling Instruments. Benjamin Franklin Hotel, Philadelphia, Pa. For information write G. L. Broomell, Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia 44.

Nov. 20-21

Seventh Midwest Conference, American Society for Quality Control, Claypool Hotel, Indianapolis, Ind. For information write Dale A. Cue, Vice-chairman, 7th Mid-West Conference, 5565 Brookville Road, Indianapolis, Ind.

Nov. 20-22

Instrument Maintenance Short Course sponsored by the Los Angeles Harbor Junior College and the Southern California Meter Association at Wilmington, Calif.

November 24-25

Fifth annual AIEE Conference on Electronic Instrumentation and Nucleonics in Medicine. New Yorker Hotel, New York. For information write American Institute of Electrical Engineers, 33 West 39th St., New York, N. Y.

Dec. 3-5

Annual Meeting and Exhibits, Society for Experimental Stress Analysis, Hotel McAlpine, New York City. For information write W. M. Murray, Sec.-Treas., P.O. Box 168, Cambridge 39, Mass.

December 10-12

Annual Computer Conference. Park Sheraton Hotel, New York. For information write B. F. Osbahr, Room 639, 480 Lexington Ave., New York City, N. Y.

1953

Jan. 14-16

Third Conference on High-frequency Measurements. Sponsored by AIEE, IRE, and NBS. To be held in Washington, D. C.

Feb. 4-6

First meeting Western Computer Conference sponsored by joint Computer Conference Committee of Institute of Radio Engineers and the American Institute of Electrical Engineers. Hotel Statler, Los Angeles, Calif.

January 29-31

Eighth Annual Symposium "Instrumentation for the Process Industries" Agricultural & Mechanical College of Texas, College Station, Texas. For information write Dr. P. G. Murdoch, Director of the Symposium.

March 23-26

I.R.E. National Convention & Radio Engineering Show. Grand Central Palace, New York, N. Y. For information write W. Copp, 303 West 42 St., New York 18, N. Y.

September 21-25

Eighth National Instrument Conference & Exhibit, Sherman Hotel, Chicago, Ill. For information write P. V. Jones, Mgr., Instrument Society of America, 1319 Allegheny Ave., Pittsburgh 33, Pa.

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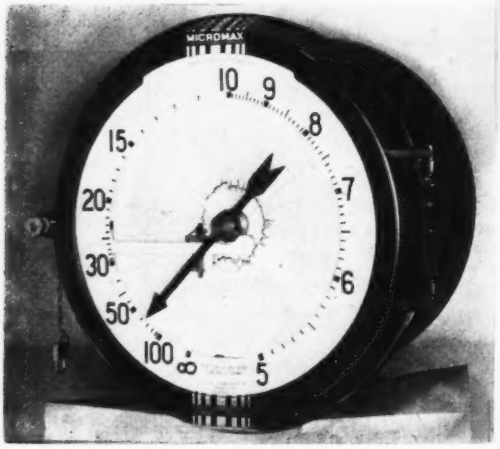
Measurement of

ELECTROLYTIC CONDUCTIVITY

By G. F. RUCKER
Dist. Mgr. Leeds & Northrup Co.

Important factors in conductivity measurements are terminology, temperature coefficient and compensation, degasification of steam samples, and instrument types.



Micromax round-chart recorder with automatically-balanced a-c. Wheatstone bridge circuit and nonlinear scale calibrated in ohms from 5,000 to infinity.

ELECTROLYTIC conductivity measurements are used widely in both laboratory and plant to determine chemical concentration. This measurement of concentration may be used to control the product strength (as in production of sulphuric acid) or to determine leakage or carry-over of a solution of one concentration into a solution of a different concentration. For example, it is possible with electrolytic-conductivity measurements to determine contamination in a condensed steam sample of a fraction of a part per million of solids.

Specific Conductance and Cell Constant

Conductivity measurements are referred to a standard called *specific conductance*. The specific conductance of a sample is the conductivity exhibited by a solution when measured in a cell having two electrodes, each with an area of one square centimeter, and spaced one centimeter apart in a container having a cross-sectional area of one square centimeter. Such a cell is said to have a *cell constant* of 1.0. Conductance is proportional to the area of the electrodes and inversely proportional to the distance between them. Thus a cell with dimensions appreciably different from those given above can have a cell constant of 1.0. The measured conductance is inversely proportional to the cell constant—that is, the lower the cell constant, the higher the measured conductance.

Cells of various constants are used. On highly conducting solutions a high-constant cell is used; on poorly conducting solutions a low-constant cell is used. The cell constant for a particular cell and the measured value of conductivity are used in converting the measured conductance to specific conductance. A measured conductance has meaning only if the cell constant is given also. The measured value then has real meaning because it can be converted to specific conductance.

Cell constants are determined by measuring the conductance of known standard reference solutions. The standard reference solutions normally used are given in Table 1.

Table 1
STANDARD REFERENCE SOLUTIONS

KCl per 1000 *grams of solution*	*Temperature of solution*	*Specific conductance*
71.135 grams	25 deg. C.	0.1134
7.419 grams	25 deg. C.	0.01285
0.745 grams	25 deg. C.	0.00141

The following equations relate the quantities involved:

Cell constant equals specific conductance/ measured conductance
Cell constant equals specific conductance × *measured resistance*

Terminology and Definitions

The terms used in conductivity measurements are resistance, conductivity, mhos, and micromhos. The trend at present is toward the use of the terms conductivity and micromhos. Conductivity is the reciprocal of resistance. The mho is the unit of conductivity. The micromho is one millionth of a mho. The trend at present is toward use of conductivity in micromhos. For example, a resistance of 5 ohms is a conductance of 1/5 or 0.2 mhos, or 200,000 micromhos. A resistance of 200,000 ohms is a conductance of 5 micromhos.

Micromhos equals 1,000,000/*ohms*

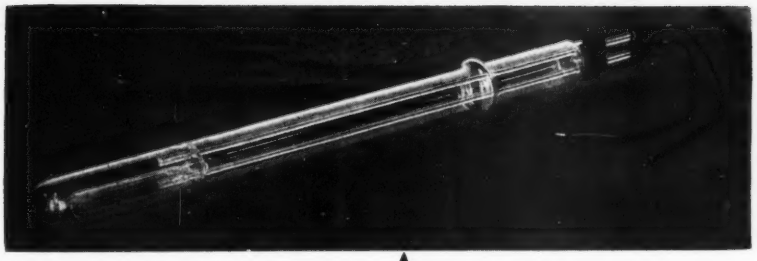
Another term used in conductivity measurements is *parts per million* (ppm.) Parts per million means grams per million cc. of solution. Occasionally the term "grains per gallon" is used, in which 17 ppm. is equal to 1 grain per gallon.

There is no specific relation between parts per million and conductance because the conductance is a function of the solution being measured. If the solution is a single-component solution, such as KCl, then it is possible to relate micromhos and ppm. specifically. But with several components present in variable ratio, the ppm. and micromho relation varies with the ratio.

The conductance of a solution is due to the ions present. The ionic conductance of many ions has been determined, and from a known analysis of a solution it is possible to calculate the *approximate* conductance, at least in dilute solutions. Such calculations can be of value, for example, in calculating the approximate conductance of boiler feed-water. Such data can be used also in determining the required instrument ranges for a new application. Usually water analyses are expressed in ionic form—that is, the number of parts per million of ions, such as calcium, magnesium, sodium, chloride, sulfate, hydroxide, etc. For each ion, equivalent ionic conductances and equivalent fac-

Presented at the Los Angeles Harbor Junior College Instrument Maintenance Short Course, Nov. 14, 1951.

"Electromax" signalling controller with electronic a-c. Wheatstone bridge signals by flashing lights to show whether conductivity is above or below a set value. When conductivity reaches maximum permissible value, instrument can also operate a valve to dump contaminated condensate to waste.



Reference cell used for ratio-type measurements and simplified automatic control. Temperature coefficients of reference acid and measured acid compensate automatically. Cell constant can be adjusted as desired from 0.6 to 2.0.

tors are known and are available from several reference sources. Multiplying the equivalent ionic conductance by the a particular ion. For example, conductivity of 1 ppm. of:

Calcium	is	0.334 micro-ohms p/cm.[3]
Chloride	is	0.469
Magnesium	is	0.227
Nitrate	is	0.875
Sodium	is	0.45
Sulphate	is	0.61

It is fairly common in power-plant applications for operators to convert micromho readings to ppm. As a general approximation the statement has been made that condensed steam, condensate, and evaporator distillate show a conductivity of 0.6 micromho per ppm. of dissolved solids when the carry-over or condenser leakage is negligible and when suitable corrections for the effects of dissolved gases have been applied. Dissolved gases effect solution conductivity in the same order of magnitude as dissolved solids.

Temperature Coefficient

Practically all solutions have a temperature coefficient of conductivity. As an approximation, the coefficient is two percent per degree C., or one percent per degree F. Dilute salt solutions have coefficients that do not vary greatly with concentration. For example, sodium chloride has a temperature coefficient of 2.12 to 2.3 percent per degree C. within a concentration range of 5 to 26 percent sodium chloride. The coefficients of acids and bases, on the other hand, vary more widely. The coefficient of sulphuric acid varies from 1.21 percent at 5 percent sulphuric acid to 2.79 percent at 95 percent sulphuric acid and 6 percent at 111 percent sulphuric acid. To make matters worse, this variation is not constant between the concentrations mentioned.

The data given are for measurements at 18 deg. C. The coefficients also vary somewhat with temperature. Therefore, any reported conductance data should specify the temperature of measurement and, unless the conductance reported is the specific conductance, the constant of the cell should be given also.

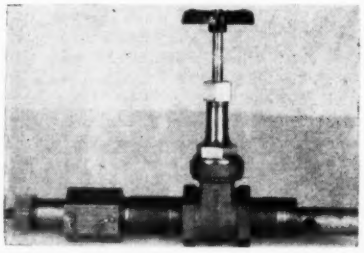
Temperature Compensation

Over limited ranges, on specific solutions, it theoretically would be possible to supply automatic temperature compensation—if there were available a resistance element of the proper resistance coefficient and stability which could be used as a compensating resistance thermometer. One approach to this problem that has been made in a few isolated cases is the use of a temperature recorder with a retransmitting slidewire which is the compensating arm of the conductivity bridge circuit. The coefficient to be automatically compensated for would have to be such that a slidewire could be wound to match it. Such an arrangement would be very special. A simpler arrangement, and the one normally used, is to use a manually-set temperature-compensating rheostat. The graduated scale connected to this rheostat is calibrated nonlinearly in temperature units. By periodically setting the temperature compensator to the observed temperature of the solution being measured, conductivity readings which are compensated for temperature can be obtained.

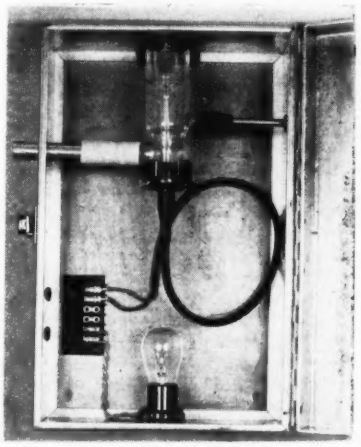
Conductivity readings usually are corrected to 77 deg. F. or 25 deg. C. Some measurements are compensated to 100 deg. F., although this is becoming less common. Proper compensation converts the reading to standard conditions.

A ratio-type measurement in which a reference cell is used as a means of automatic temperature compensation sometimes is used. This type of compensation is common for sulphuric-acid measurements. A reference cell containing a standard reference acid is immersed side by side with the measuring cell through which the flowing acid circulates. The temperature coefficient of the reference acid is the

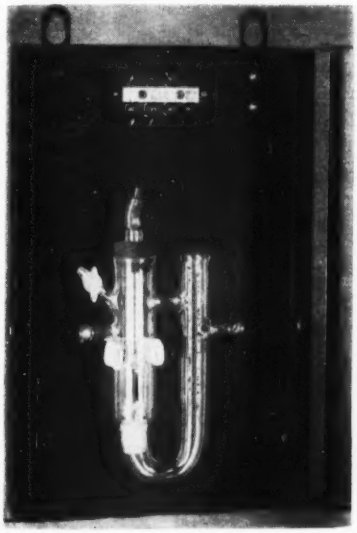
Continued on page 1462



Flow-type cell with brass removal device is permanently installed in pipe lines or tanks to detect conductivity of liquids at pressures up to 700 psi.



Conductivity cell assembly of the "Powell-McChesney" design removes non-condensable gases from steam or condensate and detects the conductivity of a condensate that is practically free of gas at a fixed reference temperature.



Flow-channel-type cell in metal cabinet is permanently installed to detect conductivity of a high-purity fluid at atmospheric pressure.

INSTRUMENTATION IN THE PULP AND PAPER INDUSTRY

Paper-making instrumentation problems include control of grinders, paper consistency, bleaching plant, and drying operations.

By DONALD B. SCRIVENS
Taylor Instrument Co.

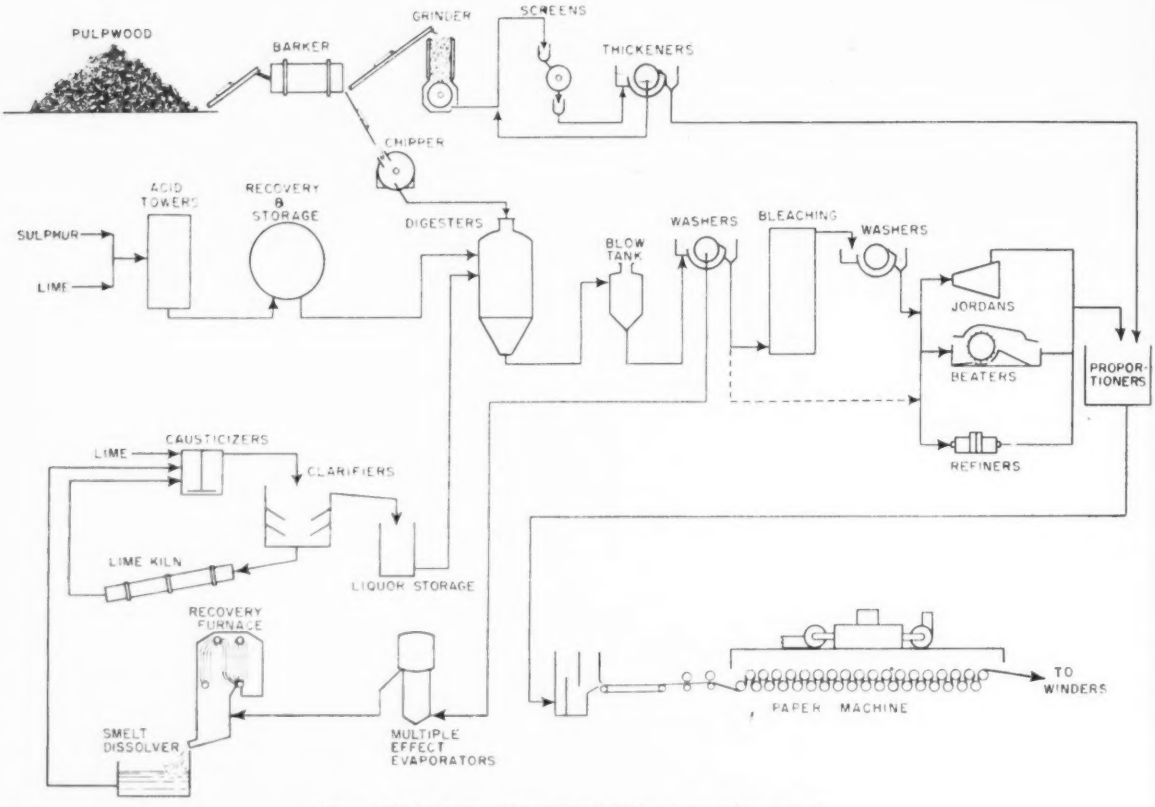


Fig. 1. Flowsheet for mechanical-separation papermaking process.

THE pulp and paper industry is playing an ever-increasing part in the economy of the United States; there are over one hundred paper mills in the southeastern part of the U. S. alone, many of them producing over five hundred tons of paper per day. Owing to the wide variety of paper products presently being manufactured, the papermaking process is complex and diverse. It would be ideal to be able to cut down a tree, and without the bother of trimming or barking it, feed it into a huge machine that would engorge it, birds nests and all, digest it, and spew forth, through a multitude of outlets, numerous products and byproducts, ranging from the lightest facial tissue to the heaviest insulating board. Certainly no such machine is ever likely to be built, but it provides good daydreaming material. A flowsheet for a papermaking process based on mechanical separation of fibres is shown in Fig. 1.

Mechanical separation of the fibres is the cheapest way to make wood pulp. Groundwood, or mechanical pulp, as the term implies, is made by forcing the wood against a revolving grindstone on which a spiral pattern has been impressed by means of a steel burring wheel. This mechanical method produces a pulp with short fluffy fibres suitable for use in newsprint, cheap magazine paper, wallpaper, etc.

Grinder Control

In the grinding operation, considerable heat is generated at the surface of the stone because of friction between the stone and the wood. The amount of heat depends on the type of burring pattern on the stone, the density of the wood, and the pressure of wood on the stone. As the burring pattern wears smooth, the temperature rises rapidly and the pulp tends to vary in color, freeness (or drainage property), and tensile strength. Excessive variation in the grinder temperature is prevented and controlled by discharging cooling water against the face of the stone.

Fig. 2 shows a continuous-type grinder in which 4-ft. logs are fed through a magazine from above on to the

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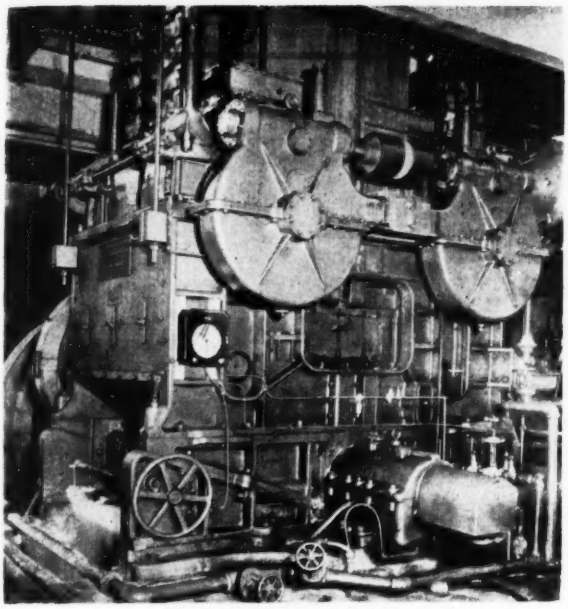

Fig. 2. Magazine-type grinder.

grindstone. Lug-equipped chains on the front and back of the magazine maintain the pressure of wood on the stone. The grindstone is about 5½ ft. in diameter and 5 ft. in width. As it weighs about 7 tons, a substantial shaft is needed for it. The shaft bearing can be seen protruding from the side of the grinder. The ground pulp collects in a shallow pit underneath the stone and spills out over a dam at the front of the grinder, shown at the bottom left hand corner of the illustration.

Temperature affects the grinding operation. Grinding at high temperatures increases the percentage of short fibres, or flour-like pulp, decreases the fibre strength, and requires more frequent burring of the stone, thus shortening its life. Conversely, grinding at low temperature produces a coarse pulp, increases the power required per ton of pulp, and decreases the grinding rate. It is therefore desirable to maintain the maximum temperature consistent with the quality of pulp desired.

One problem is to obtain the correct stock temperature. After a good deal of experimentation it was found that the best location is above the level of the stock in the pit, at a point close to the face of the stone. This bulb location eliminates trouble caused by the bulb being covered by slivers, slabs, and stagnant stock in the grinder pit. As the stone rotates, the freshly ground wood adheres to its surface and then showers itself over the surface of the bulb. The vapor-pressure-type bulb extends the width of the stone in order to detect the hottest part of the stone.

A proportional controller is usually satisfactory; it operates a control valve on the water showers at the rear of the grinder. As a safety precaution an adjustable stop screw is included in the valve to prevent it from closing completely.

Many such control systems are in use throughout the country and have proved their value in producing better-quality groundwood pulp.

Chemical Pulping

In contrast to the mechanical method of making pulp, there are several chemical and semi-chemical pulping processes. In the groundwood (mechanical) process the chemical nature of the wood is not changed. However, for chemical pulp-making, an acidic or basic liquor is digested with wood chips under elevated pressure and temperature conditions to remove the lignins, sugars, gums, etc. from the cellulose fibres. The variations in the chemical process, designated by the type of cooking liquor used, are called sulphite, soda, sulphate, and semi-chemical cooking.

The *sulphite process* uses an acid liquor of calcium bisulphite to produce a strong white pulp with long fibres and good bleaching characteristics. Its widest use is in writing paper, coated paper, and tissues.

The *soda process* employs an alkaline liquor of sodium carbonate and caustic to produce stubby, soft fibres, which find their greatest use in book paper.

The *sulphate* or kraft process also utilizes an alkaline cooking liquor (sodium sulphide and caustic) and is the most widely used process in the southern area. The resulting pulp is brown in color, long-fibred and quite strong. It is this latter property that makes it so useful for the manufacture of all kinds of bag and wrapping papers as well as box-board.

Semi-chemical Process

The chemical processes all have been an established part of the industry for many years, but one that is coming into increasing prominence is the semi-chemical process. It is doing so because the shortage of suitable pulping softwoods is becoming acute, particularly in the older paper-mill areas. As its name implies, the wood is partially digested and then the fibres are separated mechanically,

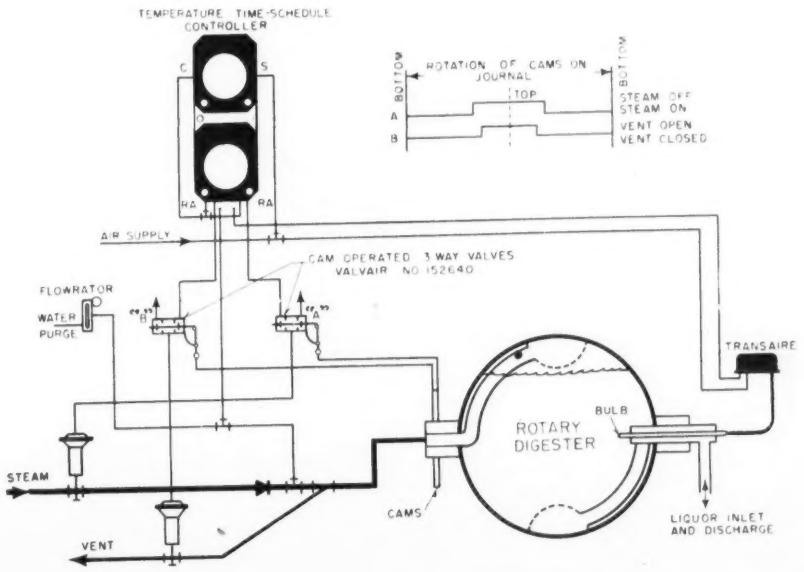

Fig. 3. Rotary digester for semi-chemical pulping, showing sequence of operation of steam and vent valves.

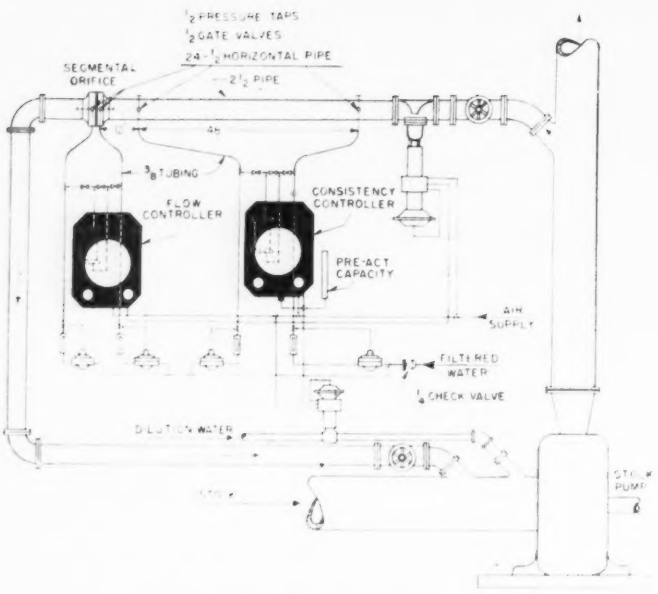

Fig. 4. Consistency control system.

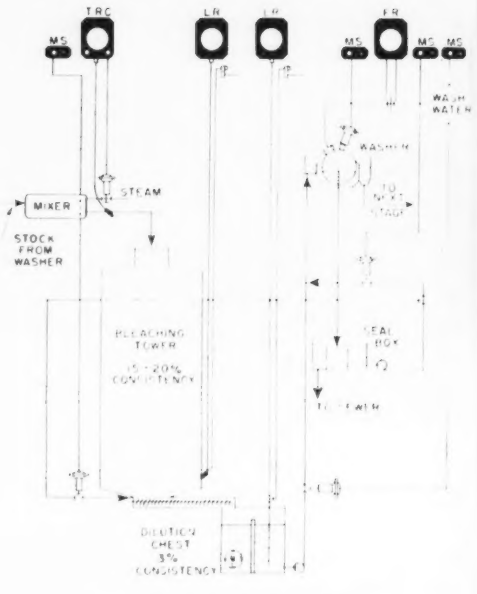

Fig. 5. Bleach-tower instrumentation.

usually by rotating disk-type refiners. There are several variations of this process—semi-chemical sulphate, acid sulphate, and neutral sulphite; all operate in similar manner and use similar equipment.

In recent years many *rotary digesters* have been installed for semi-chemical pulping (the vertical stationary type is commonly used for other types of pulping). One instrumentation problem in controlling a rotary digester is to be able to measure the temperature inside the rotating vessel and to use this as a means of actuating the controller. Another problem is to introduce steam into the digester and heat it up rapidly or to some time schedule. A third problem is to be able to vent the digester and relieve it of air and gases that accumulate as the cooking progresses, so that steam may enter the digester. This has to be done without the loss of liquor through the vent line.

The answer to these problems is provided by the system illustrated in Fig. 3. Steam enters the digester through the left-hand journal and the flow of steam is governed by the time-schedule temperature controller. The output pressure from the temperature controller must pass through pilot valve "A" before reaching the diaphragm of the steam control valve. Pilot valve "A" is held open by a cam fastened directly to the digester, which permits steam to enter the vessel only when the steam distribution dome is submerged in the liquor and chips.

The same pipe that introduces steam into the digester is used also for venting. Venting occurs just after the steam is shut off and takes place only while the end of the pipe is in the vapor and air space at the top of the digester. This is accomplished by means of pilot valve "B" and another cam fastened to the journal. Owing to the fact that steam is flowing through the internal line and distribution dome just prior to venting, it is free from liquor and none is lost during the venting period.

The vent valve may be opened a fixed amount by supplying air to it through pilot valve "B" from a reducing valve or, preferably, it may be opened inversely proportional to the temperature in the digester at any moment—by means of a mechanism in the instrument, adjusted to act as a reverse temperature transmitter. When the temperature in the digester is low the output pressure is high and the vent valve is open the maximum amount during each revolution. As the temperature approaches the desired control point the output pressure decreases and the vent valve is opened a progressively lesser amount. When the maximum temperature is reached the non-condensible gases have been driven off and venting is at a minimum.

The synchronizing of valve "A" and "B" with the rotation of the digester is accomplished by adjustable sectors on the cams. As shown by the upper right-hand corner of Fig. 3, the time during which the steam is shut off by pilot valve "A" and the period during which the vent valve is opened by pilot valve "B" is a function of the size and volume of air and vapor space above the charge in the digester. The opening through the rotating journal opposite the cams is used for the introduction and discharge of liquor as well as an access for the temperature bulb.

This digester control system was first put into operation a few months ago in a mill in New York State, with satisfactory results.

Consistency Control

One important property of pulp is consistency. Consistency is simply the percent weight of pulp in a pulp and water mixture. It is important at nearly all stages of the process because variations in consistency affect the operating efficiency of screens, filters, bleaching, and papermaking itself, as well as the capacity of tanks, pumps, and pipelines.

Although many types of consistency measuring and controlling devices have been developed and put on the market, there are only a few basic characteristics used in the detection and measurement of stock consistency, all of them of an indirect nature.

The most common method, and one on which a good deal of experimental work has been done in recent years, is that of measuring friction characteristics of pulp, either flowing in pipes or creating a torque on an agitator. One flow method is shown in Fig. 4. The operating principle is that stock viscosity changes with consistency; by measuring the pressure drop (caused by viscosity changes) for a certain flow along a definite length of pipe, the corresponding consistency of the stock can be calculated, recorded, and controlled.

The system operates in the following manner: While a constant flow of stock is maintained through a straight section of pipe, the pressure drop across a fixed length (48 inches) is used as a measure of consistency. A flow controller throttles a Saunders valve in the sample line. The flow is measured by means of a segmental orifice plate which, because it allows a smooth uninterrupted flow along the bottom wall of the pipe, minimizes the likelihood of plugging.

Another differential-pressure controller measures the friction drop across the 48-inch section of pipe and throttles

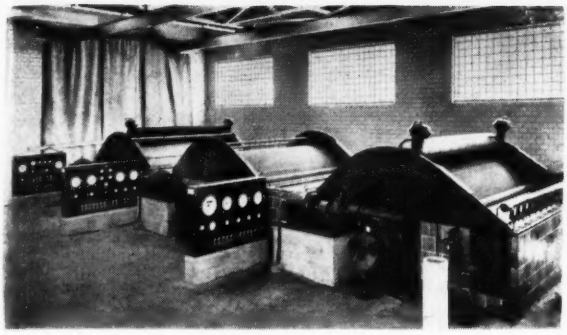

Fig. 6. Bleach-plant washer panels.

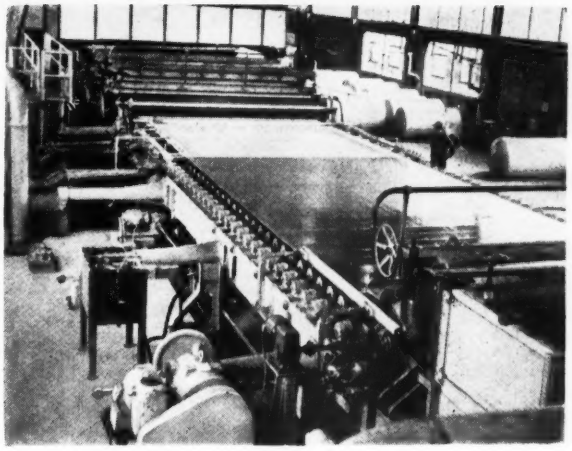

Fig. 7. Paper machine, wet end.

a valve in the water-supply line to dilute the pulp mixture and maintain the desired consistency. The measuring sensitivity can be increased by making the distance between the pressure taps more than 48 inches or by increasing the flow rate. The dilution water is added to the intake of the pump to provide thorough mixing.

The pressure taps must be water purged to keep the stock from plugging them; the piping arrangement is important. Both manometers are the bellows type to keep the volume displacement as low as possible. This minimizes the flow of stock into the taps when differential-pressure changes occur. The taps are all ½-inch size. From the tap a ½-inch pipe extends horizontally at least 12 inches and preferably 24 inches before dropping down to the manometer. Tubing of 3/8-inch O.D. is satisfactory for the lead lines. Notice in Figure 4 that the manometer bellows are on end (vertical) in order to facilitate the removal of air from the manometer body. The purge lines also are connected into the lead lines near the manometer to make sure that the pulp is kept out of the manometer. Differential flow units maintain a steady purge rate.

As published data on the viscosity-consistency relationship is scarce, it is difficult to predict the exact effect of other factors on the friction drop. These factors include stock velocity, the size and condition of the pipe, fibre length, type of pulp, bleaching, temperature, freeness (that elusive term denoting water-holding ability), etc. Some of these are controllable and others are not, but it is possible to minimize the effect of these factors to be able to get a satisfactory consistency measurement.

Even with all the discouraging aspects, control systems of the type discussed have been in operation on both sulphite and groundwood stock at consistencies from 1 to 3 percent, and it is expected that an installation for kraft stock will be made in the next few months. As this consistency range covers the majority of consistency control applications in pulp and paper processes, this method is widely applicable. It has the following advantages: (1) It is very sensitive, (2) it is highly flexible, (3) it is compact and the consistency can be measured and controlled in a line under pressure; therefore, no headboxes are needed, and (4) it is possible to control the consistency as closely as the accuracy of routine measurement done by mill testers.

Experiments are now under way to measure and control consistency at values below 1 percent; encouraging results are being obtained.

Kraft Bleaching

The bleaching of Kraft pulp has become widespread only in the past 10 to 15 years, but it is now displacing the more expensive bleached sulphite pulp from many of its formerly exclusive uses in the manufacture of specialty papers.

Multiple-stage bleaching is the rule for kraft pulp and frequently comprises six stages. Each stage includes a mixer to thoroughly disseminate the chemicals in the pulp, a reaction tower about 45 or 50 ft. in height and 15 ft. in diameter, and a washer to remove the chemicals from the pulp after the reaction is over. A typical tower with its auxiliary equipment is shown in Fig. 5. In the first stage, gaseous chlorine is added to the pulp (at 3½-percent consistency) and fed into the bottom of a tower. The pulp then is pumped to a washer where the soluble compounds are extracted in order to save chemicals in the following stages. The remaining stages are in turn designated as caustic, hypochlorite, caustic hypochlorite, and sulphur dioxide. The caustic and hypochlorite stages are usually carried out with the pulp at 15 or 20 percent consistency and are, therefore, called high-density stages. The sulphur dioxide is added as a final step to prevent color reversion.

It is important to exercise care in the addition of chemicals in order to prevent impairing the fibre strength. For this reason instrumentation plays an important part in the efficiency of bleach-plant operation. The instruments usually are grouped in small panels at each washer, with a larger main panel for the remaining instruments. A typical example of the washer panels is shown in Fig. 6.

As shown in Fig. 5, a temperature controller maintains the pulp being fed to the tower at a constant temperature. This temperature may be from 75 to 180 deg. F., depending on the particular operating conditions.

The level measurement for the dilution chest is a standard air-bubbler tube. Obtaining a satisfactory level measurement for the tower is more difficult. Pulp at 15-percent consistency is like damp cotton wadding; there is little free liquid. The diaphragm-type level transmitter has not been successful because the pulp tends to bridge across the diaphragm and does not exert the proper lateral pressure against it. Although not completely satisfactory, one workable method is to insert a 1-inch pipe through the wall of the tower at a 45-degree downward angle and have it flush with the inside. A pipe plug on the outside is removable so a rod may be used to unplug the opening. In addition to the instrument connections, a water line is connected so the pipe may be flushed out at periodic intervals.

The flow recorder measures the amount of wash water being used and a rotameter measures the quantity of chemical added for the next stage. The squeeze roll pressure on the washer is adjusted by means of air motor loading of the roll. This, as well as the stock flow to the washer and the various diluting water lines, is actuated by manual air stations on the panel.

It is common to use rubber-lined Saunders valves for stock and dilution liquor flow to overcome corrosion and plugging problems. Saunders or butterfly valves are used extensively in the industry for stock flow to overcome the tendency to plug, even though their flow characteristics are poor.

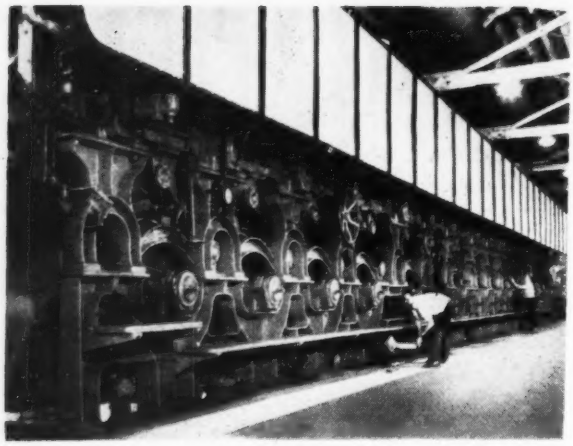

Fig. 8. Paper machine, dry end.

Paper Drying

Now we come to the paper machine and the conversion of a dilute mixture of pulp to a saleable sheet of paper. The pulp is pumped to the paper machine at approximately 0.6-percent consistency, given its final screening, and delivered to the paper-machine headbox from which it flows onto an endless bronze-wire screen. The wet end of the machine is shown in Fig. 7. The water drains through the wire assisted by vacuum boxes and a suction roll, leaving a wet sheet of paper containing about 85-percent water. The wet paper is supported on a wool felt blanket as it is stretched and passed through suction presses. At this stage, the moisture content of the paper is about 67 percent, the practical limit to which it can be reduced by mechanical means. It is then necessary to remove the excess moisture by heating the paper. As it costs approximately ten times as much to remove moisture from the paper by heating as by pressing, it is important to operate the presses at maximum efficiency.

Drying is done by a series of steam-heated hollow cast-iron rolls about 5 ft. in diameter, 100 to 300 inches in width, with a highly polished surface. There may be as many as 100 of these dryers or, as in the type of machine called a "Yankee," only one. In either type, the surface speed of the roll or rolls may be 2000 ft./min. or higher. Some of the factors affecting dryer efficiency are (1) the cleanliness of the inner and outer surfaces of the dryer, (2) the thickness of the shell, (3) the speed of rotation; at a certain critical speed, the condensate in the dryer will stop churning around and form a continuous film around the shell, thus improving the drying efficiency of the roll, (4) the amount of air or non-condensable gases; only 10 percent of air by volume in the dryer reduces the heat transfer approximately 35 percent from that of air-free steam, (5) the dryer drainage; it is imperative to keep the syphons in good condition for effective condensate and air removal, and to be able to maintain an even temperature gradient through the dryers, and (6) the wrap-around of the dryer felt holding the paper against the dryer.

Let us take a typical machine making newsprint and examine it a little more closely. Fig. 8 illustrates the dryer section of such a machine. The dryers are divided into three sections with saturated steam at 16 psig. supplied to 34 of the 51 dryers in the dry-end section from a steam turbine exhaust. The condensate is drained to a flash tank and flashed at 9 psi. to the middle section of 12 dryers. The resulting condensate is flashed again at 3 psi. for the initial 4 dryers. The remaining dryer at the dry end is water-filled, and is termed a "sweat dryer." The condensed moisture on the surface of this cold dryer roll is transferred to the surface of the paper, resulting in a smoother sheet when the paper is calendered. The final moisture content is between 6 and 12 percent. A machine like this will run at speeds up to 1800 ft. per minute and produce about 250 tons of paper a day.

Instrumentation of Paper Machine

Let us now examine the instrumentation. This is a controversial subject because every paper-mill operator has his own ideas of what controls he needs. Fig. 9 is a schematic drawing of the control system used.

The primary control is a *pressure control on the main steam supply*. With the large capacity downstream from the valve, a proportional controller is satisfactory. Where turbine exhaust steam is used without an inter-connecting header between machines, thus providing some surge capacity, a split-range valve system is used to maintain steady turbine operation.

For accounting purposes, as well as for recording of machine operation, a *recording flowmeter* is necessary. As the machine uses about 35,000 to 40,000 lbs. steam/hr., steam costs are important.

To maintain the correct differential between the sections, *ratio pressure controllers* are used to operate control valves between each section.

The control of *paper moisture* presents the most difficult problem. It is econmically desirable to keep the paper moisture as high as possible without causing a "blackening" effect on the sheet during calendering, and the printers prefer a relatively high moisture content. A moisture control is, therefore, essential for good quality paper.

Like consistency, the measurement of moisture is in-

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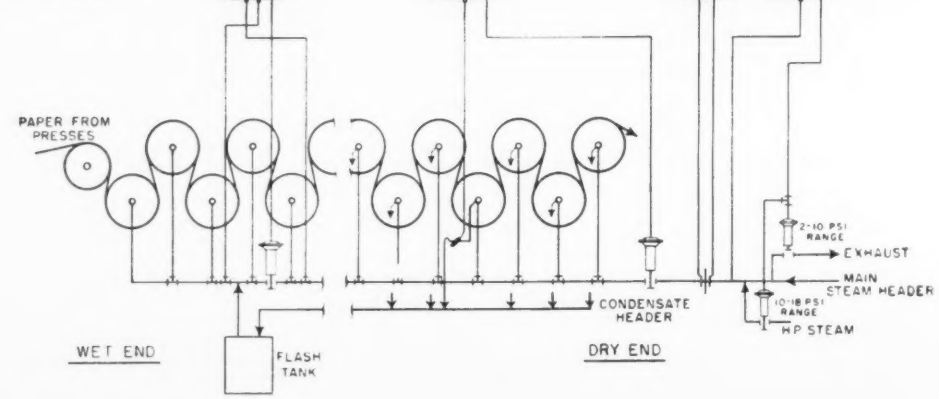

Fig. 9. Control system for dryer.

Computation of ORIFICE COEFFICIENTS

By GEORGE H. FORSTER, JR.
The Texas Company

The coefficient for orifice-meter measurements is a part of the orifice-meter formula. When the data of the meter set-up and the characteristics of the fluid being measured are known, the coefficient can be condensed into a single numerical quantity and used repeatedly so long as the data of which it is composed is unchanged.

Terminology

For gas measurement, the coefficient gives the amount of gas in standard cubic feet which will pass through an orifice in one hour at one psi. absolute pressure and at one inch differential. For liquid, it gives the gallons at 60 deg. F. which will pass through an orifice in one hour at one inch differential. For steam, it gives the amount of steam at 14.4 psi. absolute which will pass through an orifice in one hour at one psi. absolute and at one inch differential.

The term "standard cubic foot" in gas measurement is defined as: A standard cubic foot of gas is that quantity of gas which, at a temperature of 60 deg. F. and an absolute pressure of 14.73 pounds per square inch, occupies one cubic foot. All tables and equations used in the State of California give results in this unit.

Basic Equations

The equations for flow are:

Gas quantity $= C'_G\sqrt{hP_2}$

Liquid quantity $= C'_L\sqrt{h}$

Steam quantity $= C'_S\sqrt{hP_2}$

where C'_G, C'_L, C'_S are coefficients corrected for flowing conditions, h is differential in inches of water pressure across orifice plate, and P_2 is absolute pressure downstream of orifice plate.

Presented at the Los Angeles Harbor Junior College Instrument Maintenance Short Course, Nov. 14, 1951.

Orifice Coefficient (C) For Standard Orifices and Tubes

We are fortunate that the ground work has been done. Tables are prepared and simplified to the extent that coefficient calculations are a simple procedure. The *basic standard hourly coefficients*, both flange connections and pipe connections (2½ x 8), are published for standard-sized orifices in standard-sized tubes for gas, liquid, and steam. A part of a typical table of coefficients is shown in Fig. 1. The table gives the coefficient for given valves of meter-tube internal diameter (D) and orifice diameter (d). The ratio d/D is called the beta ratio (β). Beta ratios less than 0.15 and more than 0.70 should be avoided at all times, and are in italics in tables.

Coefficient For Odd-sized Orifices and Tubes

For odd-sized orifices or odd-sized tubes, the coefficient is computed from the equation:

$$C_G = d^2 ZL \quad \text{for gas,}$$
$$C_L = d^2 ZL \times 1.0056 \text{ for liquid,}$$
$$C_S = d^2 ZL \times 0.0484 \text{ for steam.}$$

Tables for Z and L are published for both flange and pipe connections. A part of some tables for flange connections is shown in Fig. 2.

Should a β be obtained which is not in the tables for Z and L, compute coefficient from the equation (for gas):

$$C = d^2 K_o 338.2$$

For liquid, multiply further by 1.0056; for steam, by 0.0484. In this equation, d is in inches, and K_o is orifice discharge coefficient, including velocity of approach factor, when Reynolds' number is infinity. The K_o for a 4.026-in. I. D. tube is called K_{o4}.

Discharge Coefficient (K_o)

The following empirical equations give K_o in terms of β and D, for flange and pipe connections:

For flange connections:

$$K_o = .5993 + \frac{.007}{D} + \left(.364 + \frac{.076}{\sqrt{D}}\right)\beta^4 + \left(1.6 - .8\beta\right)\beta^2$$

$$\left(.07 + \frac{.5}{D} - .8\right)\beta^3 - \left(.07 + \frac{.334}{D} - .5\beta\right)\beta^3 \cdot \left(\frac{.65}{D^2} + .3\right)\left(.8 - \beta\right)^{10}$$

$$U = 930 - 5000B + 9000B^2 - 4200B^3$$

$$B = \frac{.55}{\sqrt{D}}$$

For pipe connections:

$$K_o = \frac{K_e}{1 + \frac{15(U + B)}{1{,}000{,}000}}$$

$$K_e = .5925 + \frac{.0182}{D} + \left(.440 - \frac{.06}{D}\right)\beta^2 + \left(.935 + \frac{.0225}{D}\right)\beta^5$$

$$+ 1.35\beta^{12} + \frac{.043}{\sqrt{D}}(.25 - \beta)^6$$

$$U = 930 - 5000B + 9000B^2 - 4200B^3$$

$$B = \frac{.275}{D} + .12$$

Now that we have obtained the basic coefficients, the next procedure is to correct these coefficients for the flowing conditions in order to determine the correct quantity of fluid.

Example of Gas Measurement

As shown in Fig. 1, C is obtained from a table or from equation $C = d^2 ZL$. C then is corrected for expansion factor (F_{c2}), Reynold's factor (F_R), deviation factor (F_{PV}), specific gravity (F_G), and flowing temperature (F_T), according to equation:

$C' = C \times F_{c2} \times F_R \times F_{PV} \times F_G \times F_T$

where C' is the hourly gas coefficient adjusted for actual conditions of flowing gas, C is hourly basic coefficient from tables, and the others are the correction factors for expansion, etc. The square-root-chart factor (M) also is used on the right side of the equation if a square-root chart is used.

Determination of F_{c2}

The expansion factor (F_{c2}) depends on the location of the differential taps,

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d \ D	20" (19.18)	16" (15.25)	12" (12.09)	10" (10.19)	8" (8.071)	6" (6.065)
.250						
.375						
.500						
.625						*78.88*
.750						*118.89*
.875					*153.58*	*158.54*
1.000					*200.1*	200.8
1.125					253.9	254.5
1.250					313.8	314.6
1.375				*378.6*	379.4	380.0
1.500				450.9	451.7	452.6
1.625			*529.4*	529.7	530.7	531.9
1.750			*614.1*	614.4	615.5	617.5
1.875			*704.8*	706.7	707.5	709.*
2.000		*800.8*	*804.0*	805.8	806.5	814.1

Fig. 1. Portion of table for standard natural-gas hourly coefficients (C).

β	.000	.001	.002	.003	.004	.005
.10	201.4	201.4	201.3	201.3	201.3	201.3
.11	201.1	201.1	201.1	201.0	201.0	201.0
.12	200.9	200.9	200.9	200.9	200.9	200.9
.13	200.8	200.8	200.8	200.8	200.8	200.8
.14	200.8	200.8	200.8	200.8	200.8	200.7
.15	200.8	200.8	200.8	200.8	200.8	200.8
.16	200.8	200.8	200.8	200.8	200.8	200.8
.17	200.8	200.8	200.8	200.8	200.8	200.8
.18	201.0	201.0	201.0	201.0	201.0	201.0
.19	201.1	201.1	201.1	201.1	201.1	201.1
.20	201.2	201.2	201.2	201.3	201.3	201.3
.21	201.4	201.4	201.4	201.4	201.5	201.5
.22	201.5	201.5	201.6	201.6	201.6	201.6
.23	201.7	201.7	201.7	201.7	201.8	201.8
.24	201.8	201.9	201.9	201.9	201.9	201.9

Fig. 2. Portion of table for Z values used in calculation of C.

β	10" (10.192)	16" (15.250)	12" (12.090)	10" (10.192)	8" (8.071)	6" (6.065)
.11	.9988	.9983	.9981	.9980	.9983	.9980
.12	.9981	.9981	.9979	.9977	.9977	.9977
.13	.9981	.9974	.9971	.9973	.9970	.9971
.14	.9984	.9981	.9984	.9981	.9983	.9979
.15	.9993	.9991	.9991	.9990	.9990	.9988
.16	1.0010	1.0004	1.0001	1.0001	1.0000	.9993
.17	1.0013	1.0013	1.0010	.0000	1.0008	1.0000
.18	1.0018	1.0014	1.0013	1.0011	1.0008	1.0004
.19	1.0019	1.0017	1.0014	1.0012	1.0010	1.0003
.20	1.0018	1.0017	1.0016	1.0012	1.0010	1.0006
.21	1.0017	1.0016	1.0013	1.0013	1.0010	1.0003
.22	1.0019	1.0015	1.0012	1.0010	1.0009	1.0004
.23	1.0015	1.0014	1.0011	1.0010	1.0008	1.0004
.24	1.0014	1.0012	1.0011	1.0008	1.0008	1.0004
.25	1.0013	1.0011	1.0008	1.0008	1.0007	1.0002

Fig. 3. Portion of table for L values used in calculation of C.

INSTRUMENT ELECTRONICS

Basic uses of radio-frequency transmission are communication and television. Important considerations are transmission paths, antennas, and receiver types. Television principles are considered in some detail.

By MILTON H. ARONSON
Technical Editor, *Instruments*

XIII. R-F. COMMUNICATION AND TELEVISION

RADIO-FREQUENCY communication and television use modulated radio-frequency waves. The r-f. carrier wave is an electromagnetic field produced by r-f. currents in a transmitting antenna (see Fig. 11-2). As the field travels through the atmosphere with the speed of light (186,000 land miles per second, 162,000 nautical miles per second, 3×10^{10} cm. per second, or 328 yards per microsecond), it can be received a short time after transmission by erecting a receiving antenna in which the radiated field induces currents.

R-F. Transmission Paths

A radio-frequency wave travels in a straight line except when reflected, refracted, or diffracted. *Reflection* occurs from solid objects and also from the surface of the earth. *Refraction* occurs when the waves pass through nonhomogeneous medium. As the earth's atmosphere is nonhomogeneous (it has a pressure gradient), radio waves are bent slightly by the atmosphere so that the "radio line of sight" is about 15 percent greater than the visual line of sight to the horizon. *Diffraction* occurs when the wave passes over any sharp object, such as a mountain top.

The amount that a wave is reflected, refracted, or diffracted from a straight-line path depends on the frequency of the wave. Reflection occurs at all frequencies and with high efficiency at high frequencies; but diffraction and refraction decrease as the frequency increases. At low frequencies, refraction and diffraction give radio waves ranges of thousands of miles. At UHF frequencies, diffraction (by mountains) and refraction (by the troposphere) bend waves only 15 percent beyond the visual line of sight to the horizon.

Sky, Ground, and Direct Waves

Sky Waves

There are three paths that the radiated wave can take between transmitter and receiver. The sky wave (Fig. 13-1) is the wave that travels upward at an angle with the horizon and is *refracted* so greatly by the ionized portion of the atmosphere surrounding the earth that it returns to earth.

Ionosphere. The ionized atmosphere, called the ionosphere, consists of several layers of electrons and ionized atoms produced by the sun's high-intensity radiation. Ultraviolet light, as well as other intense radiation from the sun, ionizes the outer portion of the earth's atmosphere. The radiation tears huge numbers of electrons from their parent atoms and molecules and leaves a dense region of electrons, positive ions, and negative ions—the ionosphere. The effect that the ionosphere has on sky waves depends on the density of ionization, which in turn depends on the time of day and year (sun's position), the pressure of the atmosphere (number of molecules per unit volume), the composition of the atmosphere (types of molecules and atoms), solar flares, and sporadic cloud-like (sporadic-E) movements in the ionosphere.

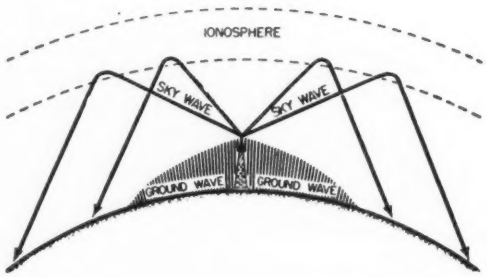


Fig. 13-1. Sky waves and ground wave of a transmitter.

These variations cause fading and temporary loss of sky-wave signal. As sky-wave signals are used for most long-range communications, tables of optimum working frequenciese (OWF) for optimum transmission are made available to the military services from the Bureau of Standards, Interservice Radio Propagation Laboratory (IRPL). Frequencies from 2 to 20 Mc. are used commonly for long-range sky-wave transmission, depending on time of day, time of year, and distance desired.

Ground Wave

The ground wave (Fig. 13-1) is the wave that is in "contact" with the earth—that is, the wave travels just above the surface and is affected by the surface of the earth. This wave induces currents in the ground, which dissipate the energy of the wave. Thus the attenuation of ground waves is more rapid than for sky or direct waves, and high-power transmission is required.

As low-frequency and medium-frequency waves are *diffracted* by the earth's curvature and *refracted* by the atmosphere, they follow the curvature of the earth and can have a reliable range of hundreds or thousands of miles, unaffected by solar variations. High-power LF stations are used for pushing radio signals across oceans when magnetic storms make sky-wave communication impossible. The disadvantage of using ground waves for long-range communication is that the antenna tower is large, expensive, and inefficient (even the highest Marconi-type tower can not be ¼ the wavelength of long-wavelength signals). The MF ground waves from 550 kc. to 1.5 Mc. are used for commercial radio broadcast.

Direct Wave

The direct wave (Fig. 13-2) is a wave that travels directly from transmitter to antenna without being affected either by the ionosphere or by the ground. As direct waves are not absorbed by the ground or the ionosphere, their attenuation during propagation is less than for sky or ground waves. As the wavelength of VHF and UHF waves

ANSWERS TO QUIZ XII.—ELECTRONIC TEST EQUIPMENT

12-1. (a)	12-6. (c)	12-11. (d)	12-15. (b)	12-20. (b)
12-2. (d)	12-7. (b)	12-12. (c)	12-16. (d)	12-21. (b)
12-3. (c)	12-8. (b)	12-13. (d)	12-17. (a)	12-22. (a)
12-4. (b)	12-9. (c)	12-14. (c)	12-18. (d)	12-23. (d)
12-5. (c)	12-10. (c)		12-19. (c)	12-24. (c)

Test Items for XIII—Page 1456

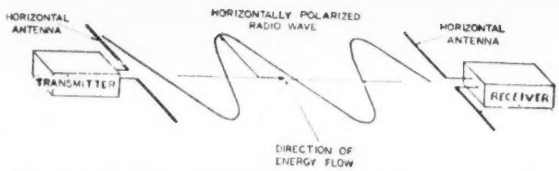


Fig. 13-2. Hertz-type doublet antenna transmitting a horizontally-polarized direct wave to a similar receiving antenna.

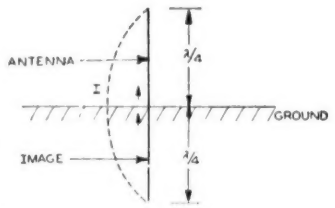


Fig. 13-3. Marconi antenna, showing how the ground acts like a mirror to produce an effective half-wavelength antenna.

is small enough to make efficient antennas possible at these frequencies (see Table VIII), VHF and UHF direct waves are used extensively for "line-of-sight" communication, television, and telemetering. Their range is about 15 percent more than the line-of-sight to the horizon because they are diffracted slightly when passing over irregularities in terrain, and also refracted slightly by the pressure gradient of the atmosphere.

Antennas

Both transmitting and receiving antennas are simply conductors in which r-f. currents are caused to flow. The purpose of a transmitting antenna is to convert current in the antenna into an eletromagnetic field. The purpose of a receiving antenna is to convert the electromagnetic field into current in the antenna. It is interesting to note that the transmitting and receiving characteristics of an antenna are identical—one is the same as the other in efficiency, power gain, and radiation pattern (directivity).

For maximum efficiency, the length of an antenna should be ½ the wavelength of the wave radiated or received. This is the shortest that the antenna can be and yet be "resonant"—that is, have standing waves of current and voltage. When the antenna is resonant, maximum current exists in the antenna and there is maximum efficiency of transfer between electromagnet field and antenna current.

There are two basic types of antennas—Hertz and Marconi. The *Hertz* antenna (Fig. 13-2) is operated at a distance above ground, may be operated horizontally or vertically, and is one-half wavelength from tip to tip. The *Marconi* antenna (Fig. 13-3) is ¼-wavelength in length and operates with one end grounded (usually through the coupling coil to the transmitter); the conducting ground plane acts like a mirror so that the ¼-wavelength antenna is effectively a ½-wavelength antenna. Any conducting, large surface (such as an airplane fuselage) can be the "ground plane" for a Marconi antenna. The dotted line in Fig. 13-3 shows the current distribution in the antenna.

The half-wave Hertz, also called a half-wave *doublet* or half-wave *dipole*, is used at higher frequencies (above a few megacycles per second), where the wavelength is small. The grounded Marconi is used at lower frequencies because it is only half as long as the Hertz.

Polarization

The polarization of a wave refers to the direction of its electric field. A horizontal antenna produces electromagnetic waves with horizontal electric field and vertical magnetic field; only horizontal receiving antennas can receive horizontally polarized waves. Vertical transmitting antennas produce vertically polarized waves, which can be received only by vertical receiving antennas. Fig. 13-2 shows a horizontal Hertz doublet producing a horizontally-polarized direct wave which is being received by a second horizontal dipole. Fig. 13-3 shows a vertical Marconi, which produces a vertically polarized wave, and which requires vertical receiving antennas.

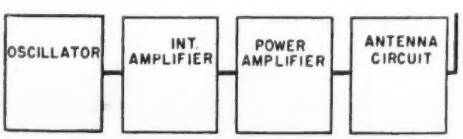


Fig. 13-4. Block diagram of a transmitter.

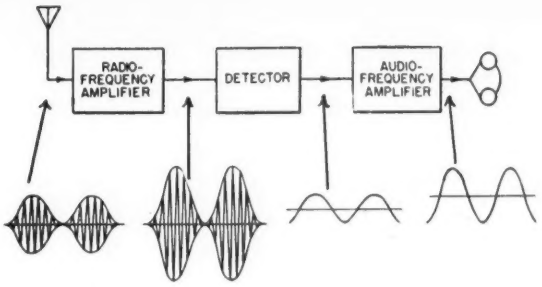


Fig. 13-5. Block diagram of a t-r-f. receiver, showing r-f. and a-f. signals.

Transmitters

A transmitter has two essential components—an oscillator and an antenna. Most transmitters have a *power-amplifier* (p-a.) stage that amplifies the weak output of the oscillator (Fig. 13-4) and also an intermediate *buffer* amplifier that isolates the oscillator from the changes in the power-amplifier stage that occur when the p-a. stage is modulated. Either the oscillator or the power amplifier (or both) can be modulated by any of the methods discussed in chapter 11.

T-r-f. Receivers

The tuned-radio-frequency (t-r-f.) receiver (Fig. 13-5) consists of one or more stages of r-f. amplification, a detector, and an audio-frequency (or video-frequency) amplifier. The r-f. amplifier stages are tuned to the frequency of the transmitter. Thus these stages must be tunable to every station in the band to be received. The detector converts the a-m. r-f. wave directly into an a-f. wave. The a-f. amplifier amplifies the output of the detector. Most of the signal amplification occurs at the radio frequency.

The *advantage* of the t-r-f. receiver is good fidelity because the r-f. amplifiers have wide bandwidth.

The *disadvantages* are (1) all r-f. amplifiers must be tuned to the r-f. signal, (2) r-f. amplifiers have low gain at high radio frequencies, (3) the gain is not constant at different frequencies, and (4) the wide bandwidth leads to poor selectivity—that is, the receiver can not discriminate between stations at adjacent frequencies. These disadvantages are overcome in the superheterodyne receiver.

Superheterodyne Receivers

The superheterodyne receiver (Fig. 13-6) differs from the t-r-f. receiver in that a *local oscillator* is used to heterodyne the r-f. signal to a lower *intermediate frequency* (i.f.)

Most of the amplification occurs at the lower intermediate

Continued on page 1444

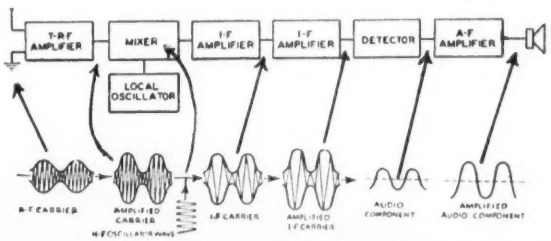
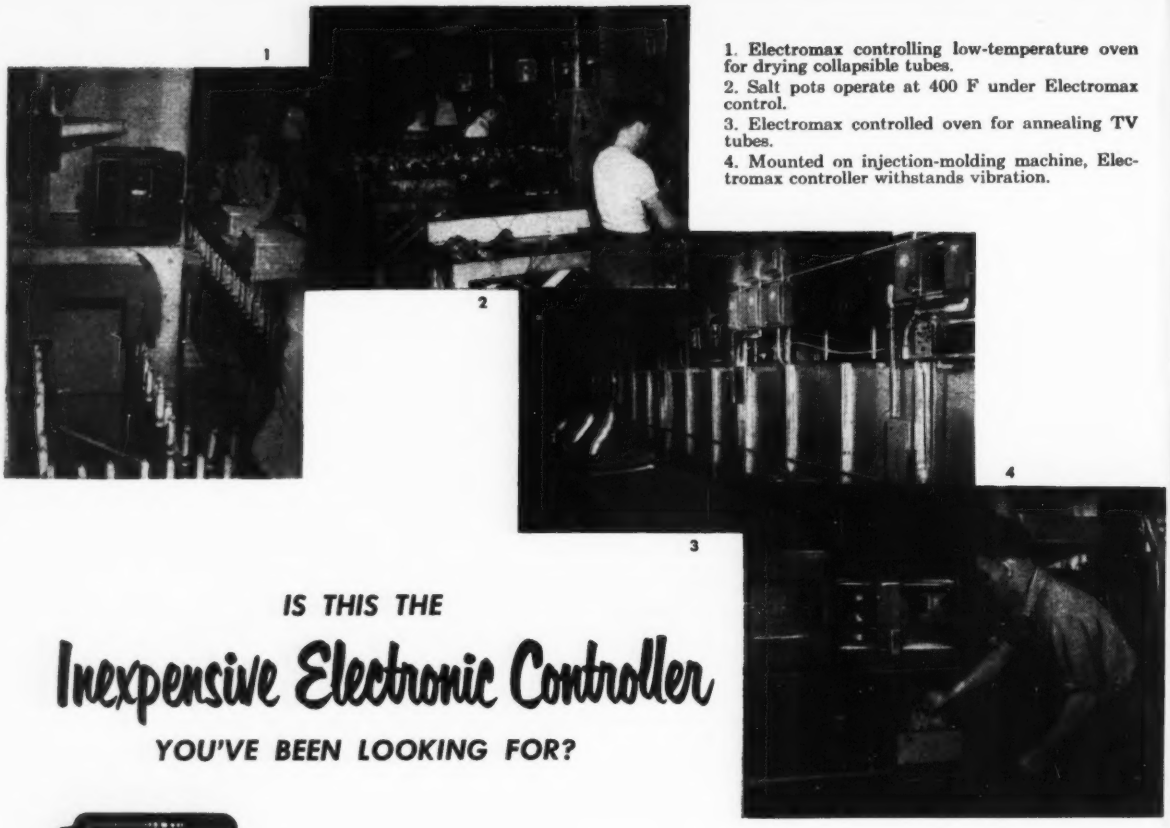


Fig. 13-6. Superheterodyne a-m. receiver.



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INSTRUMENT SOCIETY of AMERICA Journal

National Office: 1319 Allegheny Avenue, Pittsburgh 33, Pennsylvania

Vol. 8 October 1952 No. 10

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THE MANAGER'S PAGE

Percy V. Jones, Jr.

THE Seventh National Instrument Conference and Exhibit was a huge success from every standpoint: total registration, satisfaction of exhibitors and from value obtained by those in attendance.

The total registration was 9,280. About one third of the total was registered on the first day.

Nearly 200 exhibitors displayed their products in 273 booths in the 26,000 square feet paid space in the Cleveland Public Auditorium. Booths donated by ISA to the cooperating societies and government agencies brought the total exhibit space to about 30,000 square feet.

The 358 instrument men who attended the Instrument Maintenance Clinic held at Case Institute came from all parts of the United States and Canada. Classes were conducted Friday, Saturday and Sunday, September 5, 6, and 7 and all the facilities of Case Institute were required for the Clinic. The highlight of the Clinic was the talk "Applications of Automatic Control" by Dr. Donald P. Eckman of the Mechanical Engineering Department at Case. The ISA film "Principles of Automatic Control" was a valuable adjunct to this talk.

The Analytical Clinic under the direction of Dr. Axel Peterson of Mellon Institute, Pittsburgh, Pa., was an outstanding success. This Clinic, which consisted of lectures and demonstrations on complex analytical instruments had a total registration of 230.

The panel discussion, "Frontiers of Instrumentation" sponsored by the Instrument Industry Committee under the chairmanship of Charles L. Saunders, proved to be a well founded "first". Many exhibitors and instrument users are looking forward to another such discussion next year.

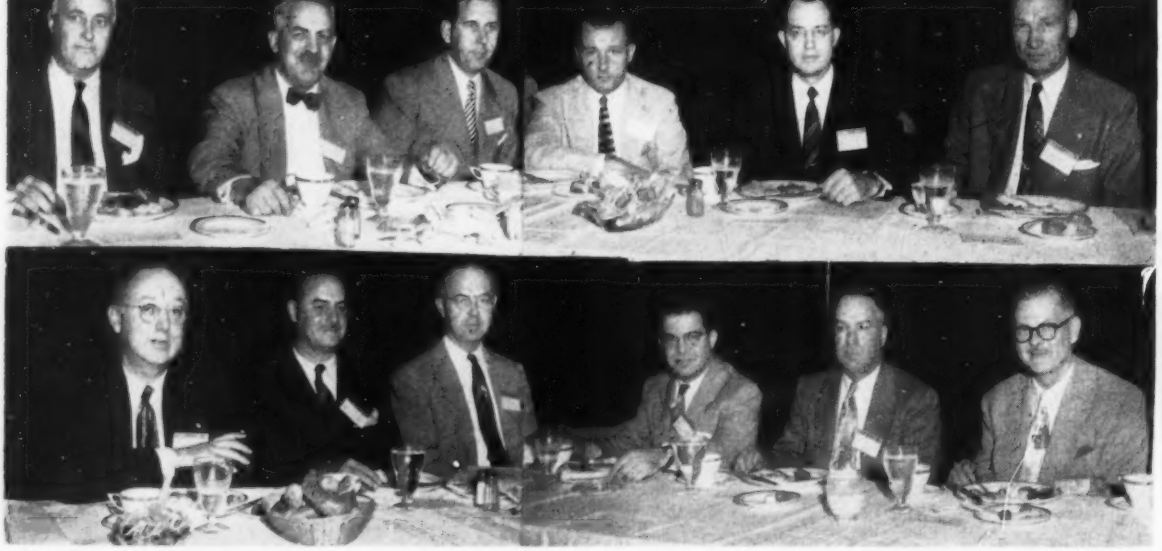
The Cleveland Host Committee, under the leadership of Fred Lennon are to be congratulated for the fine work and the wholehearted cooperation they gave to make the Cleveland Conference and Exhibit one to be long remembered.

The Cleveland Conference which was the largest ever held by the Instrument Society of America consisted of 27 Technical Sessions, comprising one hundred papers. The worthiness of these sessions was evidenced by the steady sale of preprints throughout the

I.S.A. Executive Board

Reading left to right: Vice President, R. T. Sheen; Vice President N. L. Isenhour; Past President, J. B. McMahon; Society Manager, P. V. Jones, Jr.; President-elect, Porter Hart; President, A. O. Beckman; Secretary-elect, W. A. Wildhack; Vice President, D. M. Boyd, Jr.; Treasurer-elect, J. T. Vollbrecht; Vice Presidents-elect, Warren Brand and J. M. Ribble.

ISA Members' Luncheon Speakers



First Row: Fred Lennon, J. B. McMahon, Warren Brand, George Feeley, W. A. Wildhack and A. O. Beckman.

Second row: Porter Hart, J. T. Vollbrecht, R. T. Sheen, D. M. Boyd, Jr., J. M. Ribble, and P. V. Jones, Jr.

Conference week and orders received daily at the National Office for the 1952 Proceedings. Attendance at all sessions exceeded expectations.

The accomplishments of the many National Committees which met throughout the entire week gave assurance of the continuing growth of the Society and its numerous activities.

The ISA Secretaries' Luncheon was well attended and the lively open meeting conducted by Vice President R. T. Sheen which followed, brought forth many new and excellent ideas for Section operation and membership promotion.

Foreign ISA members who attended the Cleveland Exhibit were greatly impressed, and expressed their intention of attending future meetings. G. F. Akins explained and gave the visitors a private showing of the ISA Film "Principles of Automatic Control" which may be adapted for foreign use.

News coverage of the Conference and Exhibit by technical editors as well as newspapermen was excellent. More than 50 Press kits were distributed to the Press. The fine publicity received daily in the Cleveland newspapers was due largely to the efforts of "Bill" Uhl, Publicity Chairman of the Cleveland Host Committee.

ISA T.V. Winners

George A. Whittington, editor, Industrial Laboratories, 201 North Wells St., Chicago, Ill., was the winner of the television set donated by Richard Rimbach, Exhibit Manager.

The other winner was Mrs. T. N. Gaser, 274 Manning St., Needham, Mass., whose husband is a manufacturer's representative in Boston handling Cochran Steam Specialties, etc. Mrs. Gaser's television set was donated by Fred Lennon, owner of Crawford Fittings Company, Cleveland, Ohio and General Chairman of Cleveland Host Committee.

The drawing of the television sets was the highlight of the hilarious ISA Party held September 10 in the Cleveland Public Auditorium.

Ralph Webb Named '53 Nominating Chairman

President-elect Porter Hart has announced the appointment of Ralph D. Webb as Chairman of the 1953 Nominating Committee. The appointment was made at the Executive Board Meeting held September 10 in Cleveland, Ohio. Mr. Webb is a member of the Charleston Section.

Report of the First Vice-President

BECAUSE of the great expansion in the technical work of the Society mentioned in the President's report, the First Vice-President was requested to take the responsibility for organizing new technical committees in various fields of instrumentation heretofore not specifically covered by any technical committee. Most of the existing committees had been well established and were already so numerous as to require as much time and supervision as any one officer of the Society could be expected to contribute. Mr. D. M. Boyd assumed the responsibility for maintaining the high quality of performance from these committees and for appointing new chairmen and adding to their membership. One of the previously established committees (that on Instrumentation for Measurement and Testing, Chairman: D. C. Little) appeared to be closely akin to the proposed committees and was therefore continued under the supervision of the First Vice-President.

W. A. Wildhack

The grouping of the technical committees may justify their designation as two Divisions: one on Industrial Instrumentation, one on Research Instrumentation.

The following new committees have been organized in the general areas of research instrumentation and have already been active in arranging technical sessions for Cleveland Conference:

Instrumentation for Aeronautics—
Chairman, Robert E. Tozier
Members: N. D. Sanders, I. Warshawsky

Instrumentation for Biophysics and Medicine—
Chairman, Harold J. Morowitz
Members: Robert Bowman, Raymond Jonnard, Moses A. Greenfield

Geophysical Instrumentation—
Chairman, David S. Muzzey
Member: Henry R. Joesting

Instrumentation for Testing—
Chairman, Delmas C. Little
Members: H. F. Rondeau, E. C. Rieger, C. E. Fry, J. I. Watstein, H. A. Hluchan, H. C. Roberts, G. Wassel

Meteorological Instrumentation—
Chairman, Christos Harmantas
Members: Louvan E. Wood, J. E. Dinger

Radiation Instrumentation—
Chairman, Richard W. Johnston
Members: D. L. Collins, J. R. Mahoney, S. S. Minault, F. R. Shonka, H. O. Wyckoff

Because the Society had not specifically provided a forum for people in these fields of instrumentation, only a small fraction of our membership was available for service in the new committees, and for this reason particular credit and thanks are due these committee chairmen and members who have done such a remarkably good job in arranging technical programs under such circumstances. It is confidently to be expected that the number and proportion of ISA members specializing in these fields will increase rapidly and make easier the job for these committees in the future.

The subject matter field of the Committee on Instrumentation for Testing is so broad that it has been decided to establish a Committee on Instrumentation for Measuring Properties of Materials, and Professor Howard C. Roberts has accepted the chairmanship of this committee. It is hoped that a committee may be formed in the near future on Automatic Data Reduction, Automatic Computation or on the more general field of automatic handling of data. For this year the Committee on Aeronautic Instrumentation under Mr. Robert E. Tozier, has included several papers in this general field in their excellent program.

Authorization is already contained in the by-laws for two other committees which remain inactive. One is entitled "Technical Program". The functions of such committee have been handled by the two Vice-Presidents in charge of Technical Committees, but it is probably desirable in the future to provide a committee to handle many of the details in coordinating the work of the various technical committees. A Research Committee was appointed several years ago but did not become active and has not been reactivated because a definition of its scope and activities has not been drafted. It is hoped that further discussion on the possible role of such committee will eventually lead to a satisfactory definition. It is probable that a committee which would study and report on research programs related to instrumentation conducted by, or supported by, Government Agencies, universities, and industry (insofar as made public) could be of great value to our membership, and I believe also to our Government, merely in reporting the results of such surveys and studies.

The responsibility for technical content of ISA papers lies with the Committee Chairmen and Technical Vice-President, but the excellence of the editorial presentation, which so vitally affects the clarity, readability and general value of our papers, has been greatly improved during the last year by the able editorial work of Dave Ross, who has been engaged, on a piecework basis, to insure a high level of editorial practice.

Continued on page 1445

Honored Guests and Speakers at Exhibitor's Luncheon

Reading left to right first row: Kenneth Anderson, Porter Hart, Howard A. Pringle, A. O. Beckman, Cleveland Solicitor, J. McHannan, Edward Albert, Lyle Eige. Second row: Hampton Auld, W. A. Wildhack, Paul Hurd, N. L. Isenhour, J. L. Hunter, Ed. Brennan, J. B. McMahon, R. T. Sheen. Third row: D. B. MacDougall, Richard Rimbach, Fred Lennon, E. J. Grace, Jr., W. G. Brombacher, D. M. Boyd, Jr., G. R. Feeley, A. J. Hornfeck, P. V. Jones, Jr. Fourth row: E. A Benson, S. S. Minault, J. O. Tragard, L. P. Lessing, G. W. Kelsey, S. Self, David Dietz, Charles Saunders, A. J. W. Novak.

I.S.A. Booth at the Cleveland Conference and Exhibit

Society Manager P. V. Jones, Jr. checking with his Secretary Ruth Miller on the sale of ISA Luncheon and Party Tickets.

Social Activities, Luncheons and Breakfasts

(1 and 2) The Ladies' Tea held in the Empire Room of the Cleveland Hotel. The ladies also visited Nela Park. (3) These gentlemen were responsible for the success of the huge ISA party. Left to right: A. Howard Parker, E. C. Baran, A. E. Ehrke, and F. Ely. (4) The ISA Indians who "whooped" it up at the ISA party. (5 and 6) Scenes of the 800 party guests enjoying the entertainment and free drinks. (7) Scene of one of the Speakers and Press Breakfasts held at the Hollenden Hotel. (8) Secretaries' Luncheon held at the Hollenden Hotel.

I.S.A. Instrument Mechanics' Maintenance Clinic Draws 358

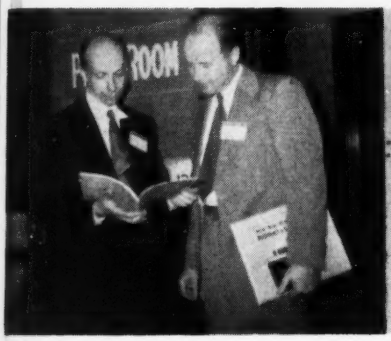
Photos were taken on Friday, September 5 at Case Institute of Technology, Cleveland, Ohio. (1 and 2) Registration; (3) Students entering Tomlinson Hall; (4) Clinic Faculty and students at lunch at Case Institute; (5) M. M. McMillen and Professor L. Siegel head of the Maintenance Clinic; (6) Students leaving the Dormitory; (7, 8, and bottom) Scenes of various Clinic classes at Case.

Candid Scenes of the Seventh National Conference and Exhibit

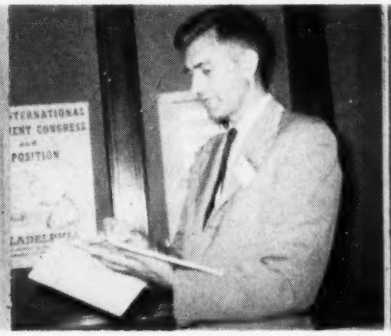
Pretty Pat Pleins taking registration for Analytical Clinic.

"Are you an ISA member, guest or member of cooperating Societies?"

Employment Registrar Lester Boss and his efficient secretary, Joan Ewing.



"We go to South Hall B for Aeronautical Instrumentation."



Recorder S. A. Hluchan making last minute notes.

Bill Uhl and Jerry Farrar moving ISA Publications.

FIRST VICE-PRESIDENT'S REPORT

Continued from page 1431

The officers of the Society recognize the responsibility that we all have to help the Society grow—to fulfill the promise of its name—to provide a technical forum for specialists in all areas of instrumentation and to promote not only *their* professional education and experience but that of all engineers and scientists concerned with instrumentation problems.

The committee structure may therefore be expected to develop further, with specialized committees being formed as rapidly as our growing membership brings together small groups who are ready and willing to arrange a program of technical activity and conference sessions appropriate to their field of specialization.

I am confident that the start made this year in broadening the technical activity of the Society will be accelerated in the future, and that this broader scope will make the Society of greatest general benefit to science, engineering, and industry.

Charter Granted

At the Executive Board meeting held September 7, 1952 the Charter for the Fox River Valley Section was approved. John R. Redgrave, 109 S. Appleton St., Appleston, Wis. is Executive Secretary This is the 58th Section of the Society.

ISA Stationery

Special ISA Stationery which will follow the National letterhead pattern, but with the local Section name and address, may now be purchased from the National office. Thus all Sections may obtain attractive stationery at a reasonable cost.

Frank M. Esch

It is with deep regret that the Houston Section announces the death of Frank M. Esch. Mr. Esch was president of Esch, Condit, Inc. and joined the Society December 1, 1948.

1953 Officers Elected

Porter Hart, past Secretary of the Instrument Society of America was elected President at the Council Meeting held Monday, September 8.

Others elected to office with Mr. Hart were: W. A. Wildhack, Secretary; Treasurer, J. T. Vollbrecht; and Vice Presidents, Warren Brand and J. M. Ribble.

Still serving on the Official Board are Vice Presidents D. M. Boyd, Jr., and R. T. Sheen, and Past President A. O. Beckman.

The newly elected officers will take up their new positions as of January 1, 1953.

Instrument Society of America

1319 ALLEGHENY AVENUE • PITTSBURGH 33, PA.

Please send me.....copies of the Proceedings of the Seventh National Instrument Conference, held at Cleveland, Ohio, September 8 to 12, 1952.

Price $5.00 to ISA members. $10.00 to all others.

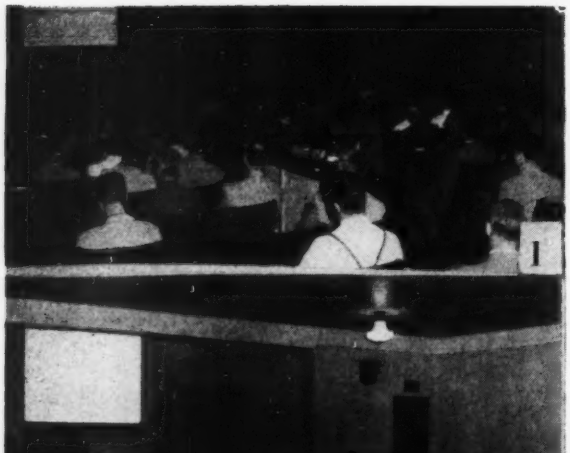
Name .....

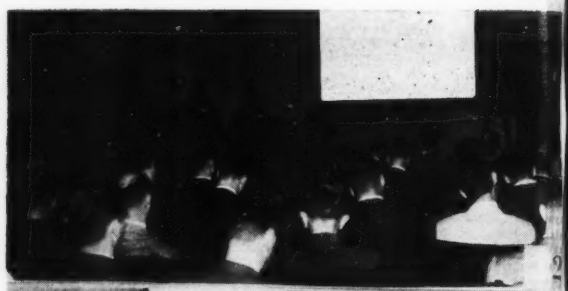
Street .....

City..... **State**.....

ISA Member - Yes ☐ No ☐ Payment herewith ☐ Send bill ☐

Session Scenes at Cleveland





(1) Instrumentation for Production Processes Session; (2) Instrumentation for Testing Session; (3) Aeronautic Instrumentation Session; (4) Operation and Maintenance Session; (5) AIEE Session; (6) Production Processes Session.

ISA EMPLOYMENT SERVICE

Forward your letter to INSTRUMENT SOCIETY OF AMERICA

1319 *Allegheny Ave., Pittsburgh* 33, *Pa.*

The following open positions were posted at the Employment Register, Seventh National Instrument Conference and Exhibit, Cleveland, Ohio, and are listed here for the benefit of those who did not attend the Conference and Exhibit and who may be interested in making application. All of the positions listed were still open at the close of the Conference and Exhibit.

INSTRUMENT ENGINEERS. To do design and job engineering in the application of pneumatic, mechanical, hydraulic and electronic instruments for chemical processes. Permanent position with liberal employee benefits. Degree in chemical, mechanical, or electrical engineering required. (a) 6-10 years experience desirable, (b) 2-3 years experience desirable. Opportunities for advancement. Location—Idaho Falls, Idaho. Box 746.

INSTRUMENT ENGINEER. Engineering design pertaining to instruments. Field work on instrument problems and development. Experience or special training preferred. Modern expanding chemical plant in Ohio Valley, West Virginia panhandle. Congenial management, excellent future possibilities. Box 747.

ELECTRICAL ENGINEERS. (Servo-Systems, Analog Computers) Career Opportunities. Immediate openings on staff of design and development engineers. Personnel with several years experience are needed to direct and participate in the theoretical development and production design of analog computers, instrument and power servos, and associate electronic circuitry. You will enjoy professional status . . .recognition for accomplishments . . . unexcelled facilities for creative work . . . modern tuition refund plan for advanced study. Continuous research and development, expansion and diversification of product lines and defense activities provide many opportunities to advance in position and income . . . plus many additional company advantages. Location: New York. Please mail complete resume of your education and experience to Box 748.

ASSISTANT CHIEF ENGINEER. Wanted by manufacturer of butterfly, slide and gate valves located in Southwestern Connecticut. Must be experienced in designing and estimating valves with manually and automatically operated control mechanisms. Attractive salary and opportunity to assume complete charge in short time. Give full details about your education and experience, to be held confidential. Box 697.

ASSISTANT TO CHIEF INSTRUMENT ENGINEER. Must have minimum of 3-5 years experience in process instrumentation. Duties will be to follow jobs from design stage through drafting, specification writing, purchasing, field installation and plant start-up. Must be willing to travel. Salary commensurate with experience. Work is in soap, soap products and detergent field. Location Northern New Jersey. Box 698.

ASSISTANT TO CHIEF INSTRUMENT ENGINEER. Graduate Engineer-Chemical, Mechanical or Electrical. 5 years experience in instrument application and specification—preferably in Chemical, Petro-chemical or Petroleum Industries for chemical plant in Detroit area. Box 699.

CHEMICAL OR MECHANICAL ENGINEERS. For sales department to contact customers as to requirements in high pressure synthesis equipment. Sales engineering customer contact. Considerable but not sustained travel. Experience necessary along these lines. Location Maryland. Box 700.

CHEMICAL ENGINEER. Man with degree in Chemical Engineering or Mechanical Engineering, with some background in high pressure synthesis, to design valves, fittings, pilot plants, auto-claves, and other items of high pressure equipment. Location Maryland. Box 701.

ENGINEERS. Mechanical-Electrical-Electronic. Several positions are available in the field of aircraft instrumentation in conjunction with the testing and evaluation of Naval aircraft. These positions offer both field and laboratory work of an interesting and diversified nature. The field of instrumentation is relatively young and is a rapidly expanding field offering unusual opportunities for advancement and a future.

Salaries to $6000 a year. Location Maryland. Box 702.

ENGINEERS. Test Engineers, Instrument Maintenance Men, Technical Writers, Environmental Test Engineers, etc. in fields of servomechanisms, general electronics, micro-wave equipment, etc. for long term program in modern aeronautical development and production. Location in a small city in north central part of U. S. Box 703.

ENGINEER, ELECTRONIC: ELECTRO-MECHANICAL. Responsible positions open for senior development and project engineers with experience in analog and digital computers, microwave radar, servomechanisms and related systems and components. Requirements emphasize advanced analytical ability and/or management experience on highly complex electronic and electromechanical systems. High salaries, employee benefits, stimulating associations with other top flight engineers. Location New York. Box 704.

ELECTRONIC ENGINEER. Electronic Computer Design Engineer—Research leading to development of own designs. Supervise operation and maintenance of complex electronic computers. Objective: Automatic data processing for the determination of space positions of aircraft and guided missiles. Young, rapidly expanding organization. Opportunity for advancement limited only by ability. Salary open. Location Ohio. Box 705.

ELECTRONIC ENGINEERS. Instrumentation, Process Control, Computers (Analog-Digital), Circuits, Networks, Microwaves. Location Ohio. Box 706.

ELECTRONIC ENGINEERS. With 5-10 years experience, to work on development and design of industrial nuclear instrumentation and similar devices. Salary commensurate with ability. Requires men with imagination, knowledge of circuits and design ability. Many opportunities for advancement. Location Ohio. Box 707.

INSTRUMENT ENGINEER. Electrical Engineer for expansion of meter development laboratory to assist in the development of commercial and military electrical indicating instruments, using various types of movements commonly associated with indicating meters. Must have knowledge of fundamental electrical circuits, and also fundamental mechanical problems associated with instrument design. Previous experience in manufacturing plant preferred but not necessary. Plant located east side of Cleveland, Ohio. Box 708.

INSTRUMENT ENGINEER. An opening exists in the Instrument & Control Section of our Plant Engineering Department. B.S. or equivalent engineering training. Scope of work runs from Instrumentation Planning with Chemical Engineering Section to making instruments work in field. If you have the educational background, we can fit the starting job to you. Salary depends on education and experience. Location New Jersey. Box 709.

INSTRUMENT ENGINEERS. Application-Contract-Production. Chemical, electrical or mechanical engineering graduates with some experience in coordinated process control or allied work. Duties involve the design, engineering, and prefabrication of control panels for the process industries and utilities. Salary Commensurate with experience. Permanent positions offering considerable opportunity for advancement. Location Chicago. Box 710.

INSTRUMENT ENGINEER. For Research and Development Department. Experienced engineer familiar with electrical, pneumatic and hydraulic elements of instruments and control equipment. Company is expanding its line of controls and gauges for water and waste treatment, and various chemical process equipment. Location will be in new air-conditioned plant located in Tucson, Arizona. Box 711.

INSTRUMENT ENGINEER. To head group setting up control systems for processing plants. Highly experienced in this work a requisite. Salary high—excellent opportunity for advancement in growing organization. Five to ten years experience in instrumentation work for chemical, petroleum or contracting companies. Work is in field at Chemical Plant Design for major chemical and petroleum companies. Box 712.

INSTRUMENT ENGINEER. (New Product Development) Expanding instrument company located in metropolitan New York City which is owned and operated by a young engineering management has positions open for engineers or physicists who are capable of independent responsibility. Applicants must have a high potential for technical and administrative growth but may have limited experience. Organization employs 500 people working in a new air conditioned plant developing and producing precision instruments which operate on the self balancing bridge principle and which apply well known physical principles through unique electrical and mechanical techniques to a wide range of problems. Box 713.

INSTRUMENT ENGINEERS. Challenging positions for young, experienced instrument engineers. Background in petroleum, chemical and /or allied fields. Flow sheet application, specification writing, and material requisition. Location Ohio. Box 714.

INSTRUMENT ENGINEER. Top grade. Must be capable of writing instrument specifications from process flow sheets and following job through drafting, purchasing, field installation, and plant startup. Desire man capable of instructing customers' instrument men in handling instruments in new refineries as they are installed. Location Chicago. Box 715.

INSTRUMENT ENGINEERS. Must me Graduate Engineer with minimum of 3 years experience in petroleum field or chemical field. Location Los Angeles. Box 716.

INSTRUMENT ENGINEERS. Specification, selection and installation of chemical plant instrumentation in connection with project design. Application of instruments to plant operations, analysis of process control requirements, trouble-shooting of plant instrument operations, analysis of process control requirements, trouble-shooting of plant instrument operation, instrument surveys, mechanic training, and assistance in plant start-up. Location Delaware. Box 717.

INSTRUMENTATION & CONTROL ENGINEERS. Unusual opportunities for Electrical, Mechanical and Chemical Engineers or Specialists. Wide variety of interesting and challenging design work in connection with industrial installations and supersonic testing facilities. Salaries commensurate with education, ability and experience. Excellent opportunities for advancement based on performance. A growing organization established in 1928. Paid vacations and holidays. Employee retirement and benefit plan. Excellent university level educational facilities. Location Missouri. Box 718.

SALES ENGINEER TRAINEES. For training program leading to field sales. Degree in physical science, freedom to relocate and for moderate amount of travel are requisites. Aptitude and desire for sales are also required but previous sales experience is not necessary. Age limits 24-30. Box 719.

SALES ENGINEER. (Analytical Instruments) Challenging position as marketing specialist in analytical instrumentation. Background required in Spectroscopy, electrochemistry, electronics. Trainee level could qualify if background satisfactory, but would prefer some experience. Location Philadelphia. Some travel. Box 720.

SALES ENGINEER. For field sales of Scientific & Industrial Instruments. Relocate and travel approx. 40% of the time. Week-ends at home. Degree in physical science and 5 yrs. experience in instrumentation required. Previous sales experience desirable but not required. Salary commensurate with experience and ability plus incentive plan after probationary period. Age limits 28-38. Box 721.

SALES ENGINEER. Covering Petrochemical, Sewage, Marine Industries for New York and surrounding territory by manufacturers of various control equipment. Drawing account plus expenses against 10% Commission. Splendid opportunity. Must travel. Box 722.

SALES ENGINEER. Graduate (or equivalent experience) Chemical Engineering, Mechanical Engineering, or Electrical Engineering. Sales and office work. Manufacturers representative—Detroit, Michigan. Leading instruments manufacturers represented. Box 723.

SALES ENGINEERS. Men with experience with industrial instruments interested in Sales and Service in Houston, Chicago, or Pittsburgh territories. Box 724.

SALES ENGINEER. Several positions open in East and Southeast Territories. Require Bachelors degree in Engineering and prefer men with Sales Engineering experience, but not essential. Good opportunities for men with proven ability. Age 28-35. Remuneration on salary basis dependent on experience and territory location. Box 725.

INSTRUMENT SALES ENGINEER. For Venezuela, S. A. Experience 3-5 years. Headquarters Caracas, Venez. Travel Eastern and Western Venez. Must have knowledge of gasoline plants, oil refineries, natural gas, transmission & distribution. Also oil field production practices. Box 726.

SALES ENGINEER. At least 5 years experience in instrument applications, preferably in process industries. Must have thorough knowledge of automatic control equipment. Must be free to travel extensively. Electrical and/or chemical engineering background helpful but not essential. Box 727.

MECHANICAL OR CHEMICAL ENGINEER FOR SALES WORK. Prefer recent graduate with some sales background. Box 728.

GRADUATE MECHANICAL AND ELECTRICAL ENGINEERS. Design, development, and test of precision instruments for aircraft and guided missiles. Design and development of electronic test equipment. High scholastic standing and experience necessary. Excellent opportunities for advancement. Salary open. Riverside, in sunny Southern California, is centrally located with relation to the mountains, desert, and ocean. Box 729.

MECHANICAL ENGINEERS. Interesting work in development of guided missile components. Degree in M.E. but no experience necessary. Excellent opportunities for advancement in a growing organization. Positions open in design, mechanical measurement, and quality control. This work is essential to the Defense Effort. Salary open depending on experience. Box 730.

MECHANICAL ENGINEERS. Four to six years experience; to work on development of precision instruments. Good background in physics required; some electronic experience desirable. Work is in field of Electronic Computers; Data Handling Systems; Research and development in fields of electronics, communications and instrumentation. Locations Minnesota and Virginia. Bxo 731.

MECHANICAL ENGINEER. Engineering work in the research and development of Prototype Instrumentation for utilization in the flight testing of experimental aircraft. Location California. Box 732.

INSTRUMENT MECHANICS. Maintenance, installation, servicing of flight test instrumentation in test aircraft. Location California. Box 733.

INSTRUMENT MECHANICS. High school graduate or equivalent, with some study preferred in electronics, physics or mechanical drawing. Shall have completed a minimum of three years experience in servicing industrial or electronic instruments. Additional education in engineering or physical science may be substituted for some of the above experience requirement. Employees will be paid a beginning rate of $2.17 per hour, with progression to $2.23 per hour. Moving expenses to the site, plus liberal employee benefits. Location Oak Ridge, Tennessee. Box 734.

INSTRUMENT MECHANICS. Highly interesting work in both industrial and electronic instrumentation and control. Excellent climate and ideal working conditions. In additional to the pay schedule listed below, there are numerous opportunities for outstanding employees to progress to supervisory and engineering positions. Trainee—$63.02 increasing to $80.59, Mechanic—$82.78 increasing to $91.56, Technician—$93.76 increasing to $95.96, Specialist—$98.15 increasing to $100.35. Extra pay for isolation areas and shift differentials. Location: Richland, Wash. Box 735.

INSTRUMENT MECHANICS. High School graduate or equivalent with training in physics and mechanical crafts. Should have experience with electronic, electrical, and pneumatic recording and controlling instruments. Should be familiar with installation, calibration and maintenance of said equipment as it pertains to the chemical industry. Salary open, dependent

upon experience and training. Liberal employee benefits. Location Michigan. Box 736.

INSTRUMENT MECHANIC CLASS "A". Wanted by Kraft Pulp Mill, Semi-Chemical, Paper Mill, Chlorine Plant, Filter Plant and Combustion Control. Five years experience with pneumatic and electrical instruments desired. Education: High School minimum; Rate: $2.16 hour—40 hour week; Location: Plymouth, North Carolina. (Payment of moving expenses will be considered.) Box 737.

DESIGN DRAFTSMEN—with instrument and/or optical knowledge and experience familiar with large scale production methods. Unlimited opportunities for men of proven ability. Location Buffalo, New York. Box 738.

DEVELOPMENT ENGINEER. Mechanical, or electrical engineering graduates to develop aircraft, Industrial and Automotive Instruments. Up to 15 years experience on design and manufacture of instruments, not installation or service. Permanent position with large stable company. Location: Toledo, Ohio. Ample salary and outstanding opportunity for capable men. Box 739.

ENGINEERS AND PHYSICISTS. B.S.,M.S., or Ph. D. Responsible positions in mechanical, chemical, electrical or electronic engineering, physics or engineering physics for advanced development and design of special equipment and instruments. Prefer men with minimum of two years experience in experimental research, design and development of equipment, instruments, intricate mechanisms, electronic apparatus, optical equipment, servomechanisms, control devices, and allied subjects. Positions are of immediate and permanent importance to our operations. Southwestern location in medium sized community. Excellent employee benefits. Box 740.

FLIGHT TEST INSTRUMENTATION ENGINEERS. For work connected with design, development, and installation of flight test instrumentation on helicopters and compound aircraft. Desire men with helicopter experience or mechanical engineering or aeronautical engineering with experience in flight test instrumentation. Location: Missouri. Box 741.

PROJECT ENGINEER. To develop pneumatic industrial measuring instruments and servomechanisms. This opening is a permanent addition to the engineering staff of a company which developed control stations, force-balance control and transmission systems, widely used in the refining and chemical process industries. Location: Philadelphia. Box 742.

SENIOR ELECTRONIC TECHNICIANS. Operation and maintenance of complex electronic computers. Supervise junior technicians. Great opportunity for advancement in young and rapidly expanding organization. Starting salary $500 per month if qualified. Location: Ohio. Box 743.

STANDARDS ROOM ENGINEER. Electrical engineer for standards room. Applicant must be capable of specifying laboratory equipment, performing acceptance inspection, and modification of such equipment. Design of special components and accessories to be used in conjunction with high accuracy measuring devices is a recurring duty. Thermoelectric and resistance thermometry procedures should be well understood both in theory and practice. Salary is commensurate with ability and experience. Location—Oak Ridge, Tennessee. Box 744.

TOOL MAKERS, SET-UP MEN, OPERATORS for Swiss Automatic Screw Machines. Highly skilled, experienced men only need apply. Location: California. Box 745.

GOVERNMENT SERVICES

To apply for any of the following Federal Agency positions, write direct to the Agency holding the position for official application form.

U. S. Navy Electronics Laboratory, San Diego 52, California

GENERAL ENGINEER. Serve as Principal Assistant to Head of Management Planning Staff for Mobilization and Facilities planning. Will apply knowledge of electronic, electrical, mechanical and structural engineering to broad planning tasks. Familiarity with research and development laboratory's field of interest is essential. $8360 per annum.

ELECTRONICS ENGINEERS. Detailed electrical measurements in the fields of radio, radar, sonar, and general electronics, including test equipment and auxiliary devices such as antenna multicouplers. $5060 per annum.

ELECTRONIC SCIENTIST. Design, develop and test systems and systems components. The incumbent will work, under supervision, in the general fields of instrumentation, data reduction, data conversion, and data display, to integrate raw combat information into a more effective form for operational evaluation and use. $4205 per annum.

ELECTRONIC SCIENTIST. Requires knowledge of general electronic theory and some knowledge of its application to military equipments, especially sonar sets and accessory devices. Work will consist of the installation and instrumentation phases of the operation evaluation of new and unfamiliar equipments with a minimum of instruction. $4205 per annum.

ELECTRONIC SCIENTIST. Convert the requirements for psychophysical test equipment into specifications for development by development groups both within and outside of the Laboratory. Develop systematic calibration procedures; liaison for instrumentation problems arising in cooperative research with other Divisions. $4205-$5060 per annum.

ELECTRONIC SCIENTIST. Assist in laboratory instrumentation and integration of man-machine combinations into shipboard systems and in the experimental study and evaluation of these systems and their parameters. $5060 per annum.

ELECTRONIC SCIENTIST. Assist in the planning and study of instrumentation and integration of man-machine combinations into shipboard systems. Familiarity and experience with techniques in radar, sonar, radio computation, control and general electronic equipment. $5940 per annum.

National Bureau of Standards, Corona Laboratories, Corona, California

GENERAL ENGINEER OR PHYSICIST. Head of the Technical Service Unit in the Missile Evaluation Section. This unit is responsible for providing the Section with laboratory and material services; assisting in missile flight tests; writing, editing and publishing technical publications of the Section; for the conduct of technical training of Section personnel; and the operation of automatic data reduction equipment.

ELECTRONIC SCIENTIST. Duties include the development of laboratory tests of instrumentation, components and systems to minimize the number of flight tests required. Also, improved flight test plans are developed to assure that maximum quality data are obtained per flight. $8360 per annum.

MECHANICAL ENGINEER. Duties include the development of laboratory tests of instrumentation, components and systems to minimize the number of flight tests required. Also, improved flight test plans are developed to assume that maximum quality data are obtained per flight. $7040 per annum.

ORDNANCE ENGINEER. Duties include the development of laboratory tests of instrumentation, components and systems to minimize the number of flight tests required. Also, improved flight test plans are developed to assure that maximum quality data are obtained per flight. $8360 per annum.

U. S. Naval Air Missile Test Center, Point Mugu, California

ELECTRONIC ENGINEER. Electronic design of shore installations for ground facilities, including flight test control centers, tracking radars, data transmission, communications, and communication relay links. Serve as specialist in problems of probable interference between various radars, intermodulation between communications systems, interferences in patchboards, raceways, etc. Supervisor of other engineers and draftsmen in preparation of electronic design plans for proposed installations. $7040 per annum.

U. S. Naval Ordnance Test Station, Inyokern, China Lake, California

ELECTRONIC ENGINEER. Design and development of electronic instruments for use in free-flight ballistic experiments on Fin-stabilized rockets. $5060 per annum.

ELECTRONIC ENGINEER. Electronic research and development in the field of measurement. $5060 per annum.

ELECTRONIC ENGINEER. Application of new theories in the field of automatic control and instrumentation. Desire extensive knowledge of servomechanisms. $5940 per annum.

ELECTRONIC ENGINEER. Development and test of electro-mechanics components of the fire control systems. $5940 per annum.

ELECTRONIC ENGINEER. Group leader for research, design, development, and operation of electronic devices for use in telemetering, Doppler, magnetic pickup, and guided missiles. $5940 per annum.

MECHANICAL ENGINEER. Design, supervision of construction and test of mechanical components. Experience with servomechanisms desired. $5060 per annum.

MECHANICAL ENGINEER. Design, develop and service instruments and devices for precise aerodynamic and ballistic performance, measurement observation on rockets, guided missiles, and other ordnance equipment. Instruments may be mechanical, optical, electrical, or combination of all three plus electronics. $5060 to $5940 per annum.

GENERAL ENGINEER. Design, develop and service instruments and devices for precise aerodynamic and ballistic performance, measurement observation on rockets, guided missiles, and other ordnance equipment. Instruments may be mechanical, optical electrical, or combination of all three plus electronics. $5060 to $5940 per annum.

PHYSICIST. Experimental work relating to development of analogue computer for aircraft fire control systems. $5940 per annum.

PHYSICIST. Engage in personal research; supervise a program in the theoretical design and development of a wide variety of specialized photo optical equipment and instrumentation, such as ballistics, trajectory, acceleration, timing phototheodolites, and other types of cameras, comparatory precision projection equipment and steroscopes. $7040 to $8360 per annum.

CHEMIST. Determine necessary instrumentation and conduct evaluation of certain explosive compositions. $5060 per annum.

Institute for Numerical Analysis, National Bureau of Standards, Los Angeles, California

ELECTRONIC ENGINEER. Work with electronic computers; electronic computer or pulse technique experience desirable. $4205—$5060 per annum.

U. S. Naval Civil Engineering Research and Evaluation Laboratory, Port Hueneme, California

MECHANICAL ENGINEER. Work related to analytical analysis in heat transmission, fluid flow and thermodynamics. $4205 per annum.

Section Secretaries, Meeting Data and Programs

AKRON
Russell F. Marquardt, 1782 Tonawanda Ave. Akron 5, Ohio. Tel: ST-6865
Fourth Tuesday, Meeting 8:15 P.M., U. of Akron, Ayer Hall, Rm. 212-B.

ALBUQUERQUE
W. E. Bostwick, 700-C Washington St., N.E. Albuquerque. N. M.
First Monday, Meeting at 8:00 P.M., Mitchell

Hall, Univ. of New Mexico.

ARUBA
J. L. Lopez P. O. Box 203, c/o Lago Oil & Transport Co. Ltd., Aruba, N. W. I. Tel. 2087.
First Tuesday, 7:30 P. M., Engr's Club.

ATLANTA
M. Virgil Davis, 357 Sixth St., N.W. Atlanta, Ga. Tel. EM. 3042
Fourth Friday, Meeting 7:30 P.M., Electric Bldg., Georgia Power Co.

BALTIMORE
G. B. Greer, 631 East 36th St., Baltimore 18, Md. Tel: CHesapeake 6879
Second Friday, Meeting at 8:00 P.M., Engr's. Club of Baltimore.

BATON ROUGE
G. M. McCarroll, 1813 Edinburgh Ave., Baton Rouge 6, La.
Meeting monthly, L.S.U. Physics Bldg.

BOSTON
Stephen E. Lord, 60 Braintree Ave., Quincy 69, Mass. Tel: MA 9-1066
Fourth Wednesday, Dinner at 6:30 P. M., Meeting at 7:30 P. M., 99 Club, 99 State St.

CALIFORNIA
Gerald B. Miller Company, 1544 Highland Ave., Hollywood 28, Calif., Tel. Hollywood 9-6305
Second Wednesday, Dinner at 6:30 P. M. Meeting at 8:00 P. M. Pasadena Elk's Club, 400 West Colorado St., Pasadena

CAROLINA PIEDMONT
L. Frank Lawrence, Minneapolis-Honeywell Regulator Co., 2400 Wilkinson Blvd.. Charlotte, N. C., Tel: 5-4422
Second Friday, Dinner at 7:30 P.M., Meeting at 8:30 P.M. Cardinal Restaurant, Charlotte, N. C.

CENTRAL ILLINOIS
Thomas A. Carroll, 721 Hurlburt St., Peoria, Ill., Tel: 4-8909
Second Wednesday, Some dinner meetings at 6:30 P. M., Meeting at 7:30 P. M.

CENTRAL INDIANA
Norman Krone, 123 N. Grant Ave., Indianapolis, Ind. Tel: IRvington 5337
First Tuesday, Meeting at 7:30 P. M.

CENTRAL NEW YORK
H. G. Murray, 169 Durston Ave., Syracuse 6, N. Y. Tel: 9-9259
Third Monday, Dinner at 6:00 P. M., Meeting at 8:00 P. M.

CENTRAL OHIO VALLEY
J. C. Dilliner, 813 Winton Ave., Belpre, Ohio. Tel: Belpre 87596
First Tuesday, Dinner at 7:30 P. M., E.S.T., Hi-Way Grille, Rt. #2, about 3 miles south of St. Mary's, W. Va.

CHARLESTON
D. A. Cunningham, 5140 Washington Ave., S.E., Charleston, W. Va. Tel. 55403
First Monday, Dinner at 6:15 P.M., Meeting at 8:00 P.M., Kanawha Airport Terminal Bldg.

CHICAGO
Floyd E. Ertsman, Rm. 1420, Fisher Bldg., 343 S. Dearborn St., Chicago 4, Ill. Tel: WE 9-0686
First Monday, Dinner at 6:30 P. M., Meeting at 8:00 P.M. Vogels, 1250 Indianapolis Blvd.
October 6th, Mr. D. M. Boyd, Jr., "Graphic Panel Instrumentation"

CHINA LAKE
Beuhring W. Pike, 606-A Essex Circle, China Lake, Calif. Tel: 77782
Third Thursday, Meeting at 8:00 P.M., Michelson Lab, USNOTS, Conference Room.

CINCINNATI
E. J. Geiser, 3666 Hubble Rd., Cincinnati 24, Ohio Tel. Ja. 5618.
First Monday, Dinner at 6:30 P. M., Meeting 8:00 P.M., Engineering Soc. of Cinn.

CLEVELAND
M. M. McMillen, Thompson Products, 2196 Clarkwood Ave., Cleveland, Ohio
Second Wednesday, Dinner at 6:30 P. M., Meeting at 8:00 P.M., Cleveland Engr. Society, 2136 E. 19th St.

COLUMBUS
Kenneth I. Lea, Battelle Institute, 505 King Ave., Columbus 1, Ohio Tel: UN-3191,Ext. 247.
Third Thursday, Meeting at 8:00 P.M., Battelle Auditorium

CUMBERLAND
Clyde Babst, 225 Cecelia St., Cumberland, Md. Tel: 583-W
Fourth Wednesday, Dinner at 6:30 P. M., Meeting at 8:00 P.M.; Ali Ghan Shrine Country Club, Baltimore Pike.

DENVER
Karl F. Kent, Jr., 5030 Umatilla, Denver 11, Colo. No regularly scheduled meetings. Univ. of Denver, Science Bldg.—Campus

DETROIT
R. A. Hoxie, Basic Service Corp., 14016 Woodrow Wilson, Detroit 6, Mich., Tel: TO-88043
Third Wednesday, Meeting 8:00 P. M., Rackham Memorial Bldg., 100 Farnsworth, Detroit, Mich.

EASTERN NEW YORK
Robert W. Carter, Sterling-Winthrop Research Institute, Rensselaer, N. Y. Tel. Albany 5-6251 Ext. 262
First Tuesday, Meeting at 8:00 P.M., Siena College, Loudonville, N. Y. Optional Dinner at 6:00 P.M., Circle Inn, Lathams, N. Y.

FOX RIVER VALLEY
John R. Redgrave, 109 S. Appleton St., Appleton, Wis.

GULF COAST
Harold Placette, 2440 Neches Ave., Port Arthur, Texas
Last Tuesday, Meeting at 7:30 P. M., Orange County Courthouse, Orange, Texas.

HOUSTON
A. Costa, 714 East 17th St., Houston 8, Texas.
Last Monday, Meeting at 8:00 P.M., University of Houston Library Building.
October 27th, Mr. Paige Buckley, DuPont Co., Orange Tex., "Valve Operators and Positioners"

KANSAS CITY
J. C. Brous, 8827 Maiden Lane, Kansas City 5, Mo. Tel: HI 8556
First Tuesday, Meeting at 7:30 P.M., U. of Kansas City, Science Bldg., Rm. 106.

LAKE CHARLES
A. T. Clinger, Columbia Southern Chemical Corp., P. O. Box 900, Lake Charles, La. Tel. 6-7522
First Wednesday after last Monday, Dinner and regular meetings at McNeese State College

LOUISVILLE
C. M. Bosworth, 5336 Westhall Ave., Louisville, Kentucky. Tel: FR 3494
First Monday, Meeting at 8:00 P.M., Seagram Auditorium.

MONTREAL
W. L. Toohey, Dominion Textiles Ltd., 1950 Sherbrooke St.,-West, Montreal, Quebec, Tel. GI 5711
Last Monday of Month, Meeting 8:00 P.M., Mechanics Institute

MUSCLE SHOALS
Atherton Hastings, Tennessee Valley Authority, Div. of Chemical Engineering, Wilson Dam, Alabama. Tel: Sheffield 3160, Ext. 6238
First Thursday, Meeting 8:00 P.M., TVA Chemical Engineering Bldg.

NEW JERSEY
Eliot R. Hill, 1125 Kensington Ave., Plainfield, N. J.
First Tuesday, Meeting 8:00 P. M., Essex House Hotel, Newark, N. J.
Oct. 7, Electrical Thermometry

NEW ORLEANS
W. H. Haney, 2927 Music St., N. O. 22, La.
No Regular Date, Meeting at 8:00 P.M.

NEW YORK
R. A. Hutcheon, 45-65 196th St., Flushing 58, N. Y., Tel: BAyside 9-5432
Third Monday, Dinner at 6:00 P. M., Meeting at 7:30 P. M., Midston House, 38th St. & Madison Ave.
October 13th, "Pipeline Instrumentation"

NIAGARA FRONTIER
Duran L. Hagler, 214 E. Delavan Ave., Buffalo, N. Y., Tel: ELmwood 1258
Dinner at 6:00 P. M., Meeting at 8:00 P. M., N. Y. S. Technical Institute, 1685 Elmwood Ave., Buffalo, N. Y.

NORTH TEXAS
R. E. Byers, 6000 Lemmon Ave., Dallas 9.

NORTHERN CALIFORNIA
Robert L. Norman, 351 42 St., Richmond, Calif. Tel: BE 2-0901
Third Monday, Dinner 6:30 P. M., Meeting 8:00 P.M., Spengers Grotto, 1919-4th St., Berkeley.
October 13th, Mr. W. A. Laviolette, "Pressure Control Aspects of the "Super-Inch" Gas Pipe Line"

NORTHERN INDIANA
J. Baum Beckman, 7145 Wicker Ave., Hammond, Ind. Second Tuesday, Meeting at 7:30 P.M., Whiting Community Center, Whiting, Ind.

OAK RIDGE
George Ritscher, 113 Gorgas Lane, Oak Ridge, Tenn. Tel. 5-1084
First Wednesday, Meeting at 7:30 P.M., Ridge Recreation Hall
Oct. 1, Joint Meeting with American Rocket Society, Movies and Lectures on Instrumentation of Guided Missiles and Rockets

ONTARIO
John W. Huether, 311 Southerland Dr., Leaside, Ontario, Canada. Tel: HU-7114
Fourth Thursday, Meeting at 8:00 P.M. Friendship Hall, College St. United Church, Toronto

PANHANDLE
George W. Leggett, Box 1526, Phillips Chemical Co., Borger, Texas

PERMIAN BASIN
J. B. Jenkins, 509 South Ave. "C," Kermit, Texas. Tel: 3220
Second Tuesday, Meeting at 7:30 P. M., Gulf Oil Corp. Auditorium or Odessa College.

PHILADELPHIA
R. A. Trenner, Energy Control Co. Rm. 306, 3147 N. Broad St., Philadelphia 32, Pa. Tel: SA 2-7900
Third Wednesday, Meeting at 8:00 P.M., Bellevue-Stratford Hotel.

PITTSBURGH
Dr. A. H. Peterson, Mellon Institute, 5500 Fifth Ave., Pittsburgh 13, Pa. MAflower 1-1100
Fourth Monday, Dinner at 6:30 P.M., Meeting at 8:00 P.M., Roosevelt Hotel
October 27th, Dr. D. P. Eckman, Case Institute, Cleveland, Ohio, "Pneumatic Control and Design"

PRESQUE ISLE
Edwin P. Schuwerk, 445½ Halley St., L. P., Erie, Pa. Tel: 2-3349
Fourth Tuesday, Meeting at 8:00 P.M., G. E. Community Center, East Lake Rd., Erie, Pa.

RICHLAND
J. R. Plee, 1309 Roberdeau, Richland, Wash. Tel: 5-8692
Second Wednesday, Meeting at 7:30 P. M., American Legion Hall

ROCHESTER
R. C. Schwartz, Jr., Foxboro Co., 1201 Granite Bldg., Rochester 4, N. Y. Tel: Hamilton 1468
Fourth Tuesday, Meeting at 8:00 P.M., Univ. of Rochester, Physics Lecture Hall

SARNIA
L. J. Hall, 730 Talfourd St., Sarnia, Ont., Canada. Tel: EDgewater 2258.
Third Monday, 8:00 P.M., Y.M.—Y.W.C.A.

SAVANNAH RIVER
F. P. Ledford, Jr., c/o Field Project Manager Ga.,
E. I. du Pont de Nemours and Co., Box 117 Augusta, Ga.

SOUTH TEXAS
H. C. Givens, La Gloria Corp., P.O. 637, Falfurrias, Texas. Tel: 122-W
First Wednesday. Meeting at 7:30 P.M.

SOUTHERN MICHIGAN
Lyle J. Draper, 2233 Oakland Dr., Kalamazoo, Mich.
Fourth Wednesday, 8:00 P. M., Dinner at 6:30 P. M., Chicken Charlie's, Kalamazoo.

ST. LOUIS
W. G. Lee, 4710 Delor St., St. Louis 16, Mo. Tel: FL 8516.
First Wednesday After First Monday, Meeting at 8:00 P.M., Engineer's Club of St. Louis.

TOLEDO
P. H. Girkins, 418 Waggoner Blvd., Toledo 12, Ohio. Tel: LA 6505
Third Tuesday, Meeting at 8:00 P. M., Service Bldg., Toledo Edison Co.

TENNESSEE
James L. Williams, 2237 Bruce St. Kingsport, Tenn. Tel: 2079-L
Fourth Thursday, Civic Auditorium.

TULSA
A. J. Sesock, 845 South East Ave., Tulsa, Okla., Tel: 8-1112
University of Tulsa Campus, Petroleum Bldg.
First Monday, Meeting at 7:30 P.M.,

TWIN CITIES
John L. Schmidt, 1879 University Ave., St. Paul 4, Minn., Tel: DR 0064
Fourth Tuesday, Dinner at 6:30 P.M., Meeting 7:30 P.M., Rm. 363, Coffman Memorial Union, U. of Minn.

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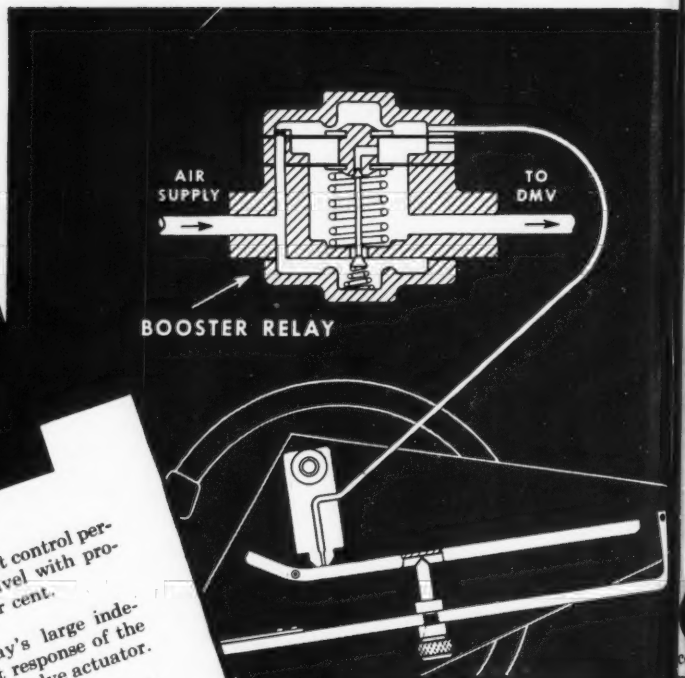

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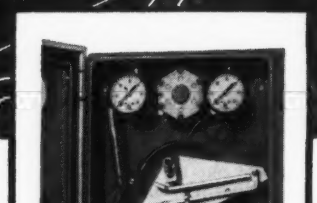

Internal view at top shows arrangement of elements depicted in diagram. External view at bottom shows Pressure Pilot with door closed.

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ORIFICE METER RUNS

By W. A. GRIFFIN
Daniel Orifice Fitting Co.

Accuracy of orifice-meter measurements depends on the meter run. Important meter-run factors include fabrication, inspection, calibration, length, and alignment.

GAS has more value today than at any time in the history of the gas industry. The many people concerned with its production, transmission and consumption are interested in accurately measuring and controlling this valuable commodity.

In the last five years there has been considerable activity by several groups such as the American Gas Association, ASME Fluid Meter Committee, and the Bureau of Standards. For example, over 6,000 tests have been conducted at Rockville, Maryland by the AGA-ASME Fluid Meter Committee and out of this work has come a wealth of data which at this writing has not been fully cataloged, classified, and published. This article presents new trends in the design of orifice-meter tubes for measurement, particularly in the light of this new test data.

Orifice-meter Runs

The physical conditions surrounding the orifice plate vitally affect the accuracy of the measurement. The pipe immediately adjacent to the orifice flange or fitting, both up and downstream, should be as nearly cylindrical, smooth, and free from blisters and scale as can be obtained commercially.

The American Gas Association Committee Report No. 2 emphasizes that the internal roundness of the meter tube is extremely important. The report states that the permissible out-of-roundness is in direct relation to the beta ratio*, as shown in Table 1. For example, with a beta ratio from 0.65 to 0.75, the permissible out-of-roundness for flange taps cannot be more than 0.5 percent. For pipe taps the out-of-roundness cannot be more than 0.2 percent. This means that with flange taps and 6-inch pipe for the meter tube, the out-of-roundness should not be more than 0.030 inch.

*Beta ratio is the ratio of orifice diameter to pipe diameter.

Presented at a regular meeting of the Southern California Meter Association.

Table 1.—Recommended maximum allowable tolerance between measured inside diameter of the upstream section of the meter run, and the published "Approximate Internal Diameter."

Beta ratio	*Flange taps*	*Pipe taps*
0.10 to 0.25	5.0%	3.5%
0.25 to 0.35	3.0	2.0
0.35 to 0.45	2.0	1.0
0.45 to 0.55	1.5	0.6
0.55 to 0.65	1.0	0.3
0.65 to 0.75	0.5	0.2

Table 1 gives recommended tolerances for meter-run diameters. The tolerances apply solely to the upstream meter tube; it is recommended that for the downstream meter tube the out-of-roundness should not exceed twice the upstream tolerance.

It should be strongly emphasized that these tolerances apply to meter tubes with orifice flange unions. The Committee further recommended that when an orifice fitting is used, the out-of-roundness should not exceed one-half of that permitted for flange taps. This means that in fabricating a 6-inch meter tube to go with a 6-inch orifice fitting, and to use beta ratios as high as 0.65 to 0.75, the upstream orifice tube cannot be out-of-round by more than 0.015 inch; the downstream meter tube should not deviate by more than 0.030 inch. The reason for this close tolerance is that an orifice fitting has a machined bore and will not be out-of-round by more than two thousandths of an inch. It is important, therefore, to hold the meter run as closely as possible to the bore and the roundness of the orifice fitting. Otherwise, a shoulder or misalignment results and sets up turbulence in the flow at a critical point.

If tolerances such as in Table 1 are adhered to, it means that meter tubes can no longer be made in the field; they should be shop fabricated. Field-fabricated meter tubes have become obsolete because the present-day close tolerances require accurate machining and welding techniques that are not available in the field.

Fabrication of Meter Runs

There are three phases in the fabrication of meter tubes: (1) selection of pipe, (2) machine and welding operations, and (3) calibration and inspection.

Selection of Pipe

In selecting the pipe, pick out pipe that is as smooth and free from blisters and scale as possible. The internal diameter of the pipe should be "miked" with a set of internal micrometers. Readings should be made on the vertical,

INSTRUMENT MAINTENANCE SHORT COURSE

The 2nd Annual Instrument Maintenance Short Course, which is sponsored by the Southern California Meter Association and presented by the Los Angeles Harbor Junior College on their campus at Wilmington, California, will take the place of the regular monthly SCMA meeting in November.

Date and Place:

November 20, 21, and 22, 1952. Los Angeles Harbor Junior College, 1111 Figueroa Street, Wilmington, Calif.

The Short Course program has been expanded to meet all levels of need. The general sessions have been expanded to cover more topics of wider interest, and a PRACTICAL METHODS section is being offered to provide actual practical experience.

Complete programs and schedules will be available at an early date. For further information contact the Los Angeles Harbor Junior College or the Southern California Meter Association.

horizontal, and both diagonal planes; in other words, a minimum of four readings in one position. The pipe should be "miked" approximately an inch inside the outer edge and then perhaps a full diameter inside. Both ends of the pipe should be "miked" because pipe varies in internal diameter from one end to the other.

When the pipe is "miked," examine the internal condition of the pipe. In recent years a great deal of seamless pipe is strongly striated and scored with long ridges, often running the entire length of the joint. Such pipe is to be avoided. There is now a tendency to use electric welded pipe. Certain manufacturers are fabricating pipe, particularly in larger sizes, in such a manner that the flash produced by the weld is removed on the inside; this pipe often is more in-round than seamless pipe. The Joint AGA-ASME Research Committee testing large orifice-tube measurement at Refugio, Texas employed eight 10-inch meter tubes which were fabricated from electric weld pipe; this pipe was so true that there was not more than 0.002 inch difference in out-of-roundness between the average micrometer reading in any one of the eight 10-inch meter tubes.

Single-random lengths should be selected which are approximately 21 feet in length, the longer 42-ft. double-random joints should be avoided. Closer control is possible with the smaller lengths because the longer sections of pipe tend to vary and become large in the middle.

Machining and Welding

The welding and machine work on the meter run depends on the design of the meter tube and the type of flanges employed. In the past it was general practice to make meter tubes using slip-on or threaded flanges; this practice probably resulted from the fact that meter tubes were made in the field. Today, however, the trend is toward the use of welding-neck-type flanges or welding-neck orifice fittings. A special internal expanding jig (Fig. 1) has been developed which is installed partly in the welding-neck flange and partly in the pipe. This jig lines up the flange and pipe and prevents formation of icicles on the inside.

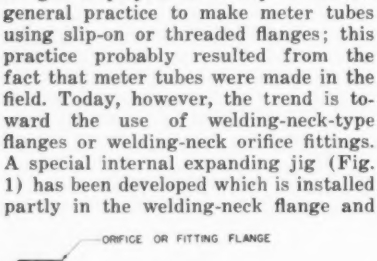

Fig. 1. Internal alignment jig for lining-up pipe and welding-neck flange.

A special bevel should be used on both the flange and the pipe, which permits the welding rod to penetrate to the bottom of the joint. This eliminates any possible gap and furnishes a full fusion weld. The jig prevents distortion or tendency to push in due to the temperature.

After the welding is finished, the jig may be driven out. When using a welding-neck flange it is not necessary to reface the flange or to otherwise machine the meter tube. With this method, extreme care should be exercised in the selection of the pipe because the pipe must match the inside diameter of the welding-neck flange or fitting within a few thousandths. Otherwise the expansion of the jig will be controlled by the smallest I.D. and a smooth internal joint will not be obtained.

Inspection and Calibration

After the meter tube is fabricated in the shop it is ready for inspection. It is recommended that this inspection be done by a trained machinist. The finished meter tube should be "miked" by the inspector at the face of the flange. It then should be "miked" half a diameter inside of the tube and then a full diameter; thus the inspector has a minimum of twelve micrometer readings, giving him a representative average of his meter tube.

Inspection of the meter tube also should embrace a close examination of all welded spuds, thermometer wells, test wells, etc. The edges of these holes on the inner surface of the pipe should be free from burrs; all connections should be located to conform to the American Gas Association recommendations.

Meter-tube Lengths

The meter-tube length is related directly to the general piping design and whether or not control equipment and valves have been installed either up or downstream to the meter tube. It is a safe rule to eliminate bends and piping designs which cause turbulence upstream from the meter tube. A smooth streamlined flow approaching the orifice is of value in securing accurate measurement. The early AGA Committee which conducted tests at Buffalo, New York in the 1920's observed that piping combinations upstream to the meter tube (where there were three elbows in three different planes) made the test meter read low by as much as 10 to 20 percent. The elbows used in the early tests were mitered elbows.

During the AGA-ASME work at Rockville in 1949 the Committee noted a reverse effect when working with three elbows in three different planes; the meter read high. In this latter instance, however, smooth streamlined weld ell fittings were used instead of the rough mitered joints employed in the early tests. The Committee at Rockville then decided to duplicate the early conditions, using three welded miter ells in three planes on a 4-inch line. Results of the test at 10½ pipe diameters gave low readings by 10 percent. This confirmed the early Buffalo findings and points out that smooth streamlined flow upstream from the meter tube is of considerable importance. In this test program, straightening vanes then were installed, which eliminated the low readings and corrected the turbulent conditions. Examination of the straightening-vane data at Rockville seems to indicate that the installation of straightening vanes sometimes overcorrected the error, particularly on short meter tubes (6½ pipe diameter). This straightening-vane data is still being evaluated by the joint AGA-ASME Committee on Orifice Meters.

Fig. 2 shows the length of straight pipe required between the orifice plate and the plug valves for both flange taps and pipe taps, when the plug valve is in the riser and the plug-valve axis is parallel to the pressure taps. This data indicates that with flange taps and 0.725 beta ratio, it is possible to shorten the upstream meter run length to approximately 11 diameters and still not have any effect on the measurement. With pipe taps and the same conditions the maximum usable beta ratio drops to 0.65.

When the plug valves are placed in the meter tube rather than in the risers (the upstream run is still 11 pipe diameters) and with flange taps, the maximum usable beta ratio drops from 0.725

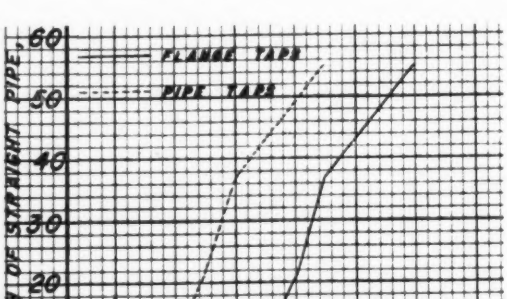

Fig. 2. Length of straight pipe (in pipe diameters) required between orifice plate and plug valve in riser for zero effect. The data is based on the 1949 tests with 4-inch pipe. Plug valve axis is parallel to pressure taps.

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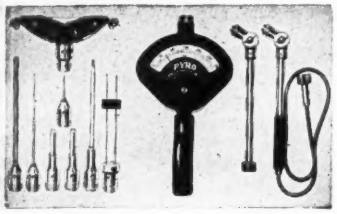

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to 0.65. With pipe taps and the same conditions, the beta ratio drops from 0.65 to 0.55. This indicates that when short tubes are contemplated the plug valve should be installed in the riser. The data does not imply that longer meter tubes are inadvisable. To the contrary, where space is not a limiting factor present practice indicates that 25 pipe diameter upstream (with removable straightening vane) and 15 diameters downstream are excellent lengths for accurate measurement.

Alignment Methods

As orifice fittings are used universally in the gas industry, the proper alignment of the meter tube with the bore of the orifice fitting is extremely important. It is advisable to line up the upstream meter tube with the fitting and then reach through the fitting and use a straight edge rule on the internal bore to make sure that the alignment is as nearly perfect as possible.

For shop-fabricated meter tubes it is recommended that dowel pins be used to align the bore of both up and downstream meter tubes with the up and downstream bore of the fittings. For 600-pound ASA flanges and higher, it is possible to use a male and female face on the flanges and thereby align the internal bores. It is also possible to ream two diametrically opposite bolt holes and use snug-fitting bolts. In any event, it is most important that this alignment be obtained through one of the many available means. It is advisable to use gaskets that have been cut especially for the installation. The outside diameter of the gasket should be cut so as to force the bolts out in the bolt circle. The inside diameter of the gasket should be cut one-sixteenth of an inch larger than the inside diameter of the line; thus, when the flange is made up and the gasket compressed, there will be no chance of it slipping or expanding into the line.

Honed Meter Tubes

No discussion of present-day meter-tube practices is complete without discussing honed meter tubes. These have been employed for over twelve years, primarily on the West Coast; however, today many of the utility systems in the Gulf Coast and mid-continent areas, as well as in the East are installing honed meter tubes for use with orifice fittings.

Honed tubes are more expensive. Their manufacture is a slow process because pipe having such a relatively thin wall expands and contracts during the honing process. Another factor is that honed meter tubes are more or less true cylinders and usually have a tolerance in the neighborhood of plus or minus 0.004 at any point in the entire meter-tube length. The inside finish of a honed meter tube depend, on the grid of the stone used; any desired degree of roughness can be obtained. Smooth meter-run tubing from the tube mill generally has a No. 50 finish in the microinch roughness scale. Medium to rough pipe is from 200 to 450 in the microinch roughness scale. These finishes can be duplicated in the honed meter tube and it is recommended that a microinch roughness of approximately 125 be used.

At the present date information about comparative measurement through honed meter tubes and conventional pipe is limited. Most of the data indicates that a honed meter tube (or a meter tube which has been fabricated from special meter-run tubing) provides a higher measurement than a meter run fabricated from conventional pipe. This may indicate that the honed meter tube, being a more perfect cylinder throughout its entire length, provides more accurate measurement than standard pipe whose out-of-roundness can be ascertained only at either end. Future tests and comparisons will shed more light on this phase of meter-tube performance.

In summary, the natural consequence of the increased value of gas has been an increase in the desire for more accurate measurement. One of the large transmission companies transporting gas from the Texas Gulf Coast to the Eastern Seaboard handles in excess of fifteen billion cubic feet per month; over the last ten-month period their measurement balance checked within 0.04 percent. Such an accomplishment indicates the universal trend in the gas industry toward higher accuracy.

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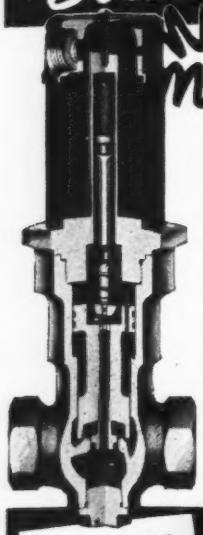

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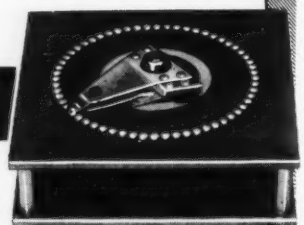

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INSTRUMENT ELECTRONICS

Continued from page 1327

frequency rather than at the higher carrier r-f. frequency, as in the t-r-f. receiver. Many broadcast receivers have an i.f. of 456 kc. Thus if it is desired to receive a station transmitting on 1500 kc., the local oscillator is tuned to 1956 kc. The difference frequency of 456 kc. appears at the output of the mixer, or first detector, which mixes the r-f. signal with the local-oscillator signal. If it is desired to receive a station at 500 kc., the local oscillator is tuned to 956 kc. Thus all stations are, in effect, heterodyned to 456 kc. before amplification.

There are many advantages to performing the amplification at the fixed and lower intermediate frequency rather than at a tunable radio frequency—(1) since the gain of an amplifier decreases as frequency increases, the lower-frequency i-f. amplifier has greater gain per stage; (2) since the i-f. amplifier need not be tuned to every station, the gain is not disturbed when tuning, and (3) the fixed-frequency i-f. stages can be tuned sharply, resulting in high selectivity (although at the expense of bandwidth, or fidelity).

Image Frequency

One minor disadvantage of the superheterodyne principle is that there are *two* r-f. signals that can produce an i-f. of 456 kc. at any one local-oscillator frequency. For example, if the local oscillator is operating at 956 (to receive a station at 500 kc.), a station at 1412 kc. also will produce a 456-kc. signal (1412−956 = 456) if it reaches the mixer. Thus two stations can be received simultaneously—one above and one below the frequency of the local oscillator. Note that one is the "true signal"—as indicated by the receiver dial; the other undesired station, called the *image frequency* of the desired signal, is received even though its frequency is twice the i.f. away from the true signal.

Image frequencies can be avoided by use of t-r-f. stages, which pass only the desired radio frequency. Image frequencies are important in military radio and radar countermeasures work, in which the spectrum is analyzed for all r-f. transmissions. In such work, image signals must not be confused with the indicated frequency. They are important also in receiver design—the i.f. must be chosen so that images do not interfere with normal reception.

In many receivers the t-r-f. amplifier preceding the mixer is omitted. However, this r-f. amplifier gives greater sensitivity, rejects image frequencies, and also keeps the oscillator signal from reaching the antenna, where it can be radiated and cause interference or violate radio silence of military forces. Because of its high gain and high selectivity (the i-f. amplifiers can be tuned sharply), the superheterodyne is the most popular of all receivers.

The oscillator is called "local" because it is in the receiver. It is made tunable so that it can heterodyne any r-f. signal of any frequency (within its band, of course) to the frequency at which the i-f. amplifier is tuned.

The detector that converts the i-f. signal into the a-f. signal often is called the *second detector* because the mixer is the first demodulator, or first detector, in the circuit.

F-M. Superheterodyne Receiver

Fig. 13-7 shows a superheterodyne receiver for f-m. reception. The local oscillator and i-f. stages function as in the a-m. receiver. However, the second detector is a discriminator which converts the frequency-modulated inter-

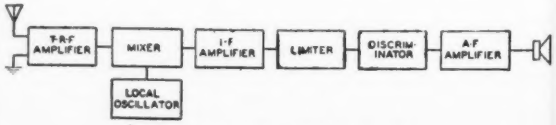

Fig. 13-7. Superheterodyne f-m. receiver.

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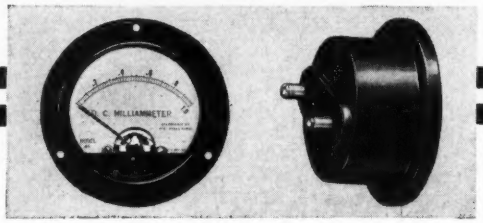

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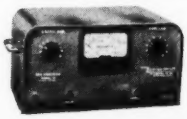

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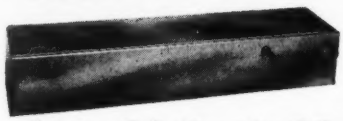

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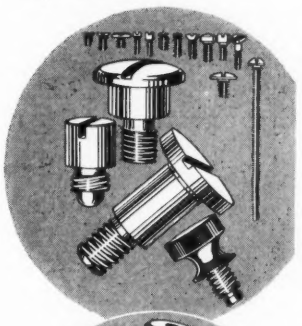

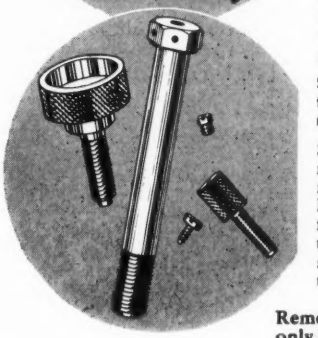

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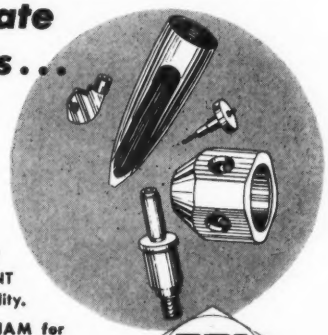

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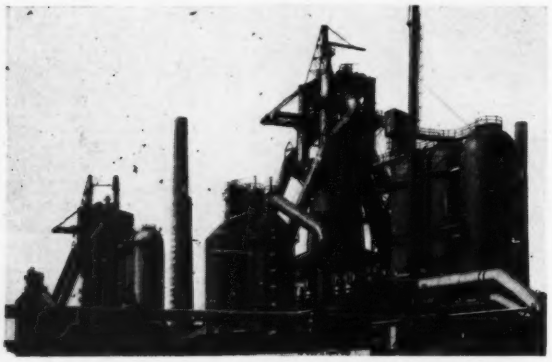

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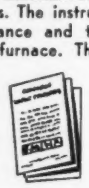

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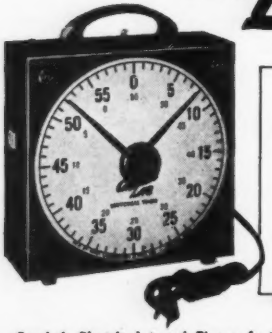

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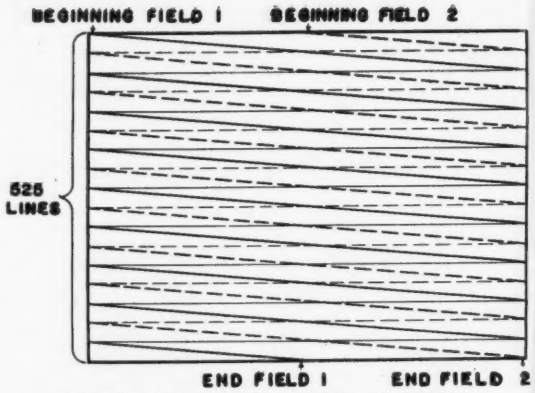

Fig. 13-8. Interlaced scanning procedure for television.

mediate-frequency wave into amplitude-modulated audio frequency signals. Discriminators were discussed in Chapter 11.

Television

Television is a system for transmitting and receiving a visual scene by means of amplitude-modulated radio-frequency waves. The sound associated with the visual scene is transmitted at the same time, but on a different (frequency-modulated) carrier, thus reproducing both the sight and sound of the televised scene. The sound carrier frequency always is 4.5 Mc. below the video-signal carrier frequency in broadcast TV.

The television system transmits "still" pictures, the effect of motion being achieved by a rapid succession of still pictures, as in moving pictures. Each "still" picture is reproduced at the television receiver by *intensity modulating* a cathode-ray tube—that is, by changing the beam brightness as the beam scans the face of the tube in exact synchronism with a similar scanning procedure in a camera tube at the transmitter.

The camera tube originates a sequence of electrical signals, the amplitude of which is proportional to light intensity. The scanning of the entire scene at the transmitter is done electronically by sweeping an electron beam horizontally and vertically at the same time (Fig. 13-8). The horizontal sweep is the rapid sweep, with a duration of less than 1/15,000 second (for one sweep from left side to right side); the vertical sweep is the slow sweep with a duration of about 1/60 second (for spot to traverse from top to bottom). Therefore, one complete "field" requires 1/60 second.

Interlaced Scanning

In order to obtain a "still" picture with high resolution, many (500 or more) scanning lines are required; and in order to obtain a "moving" picture without flicker, 50 or 60 individual "still" pictures are required each second. However, an excessive bandwidth results if 500 lines are transmitted within 1/60 second. Interlaced scanning is used to overcome this problem.

In interlaced scanning (Fig. 13-8), field 1 begins at the top left corner of the tube and the spot traverses 262½ lines to end at the middle of the bottom of the tube. The spot then rapidly jumps to the center of the top of the tube and traverses 262½ sweeps to end at the end of field 2. Each line of field 2 falls *between* the lines of field 1. The result is that each complete picture, or *frame*, contains 525 lines (262½ lines on each field), resulting in high resolution. Although the frame frequency is 30 per second, the 60-cps. field-frequency eliminates flicker. The broadcast television picture thus contains thirty 525-line images per second, delivered in 60 fields per second.

The receiver scan is synchronized with that of the transmitter at the beginning of each horizontal sweep (at intervals of about 1/15,000 second) and at the beginning of each vertical sweep (at intervals of 1/60 second). Thus the beam of the receiver cathode-ray tube moves in exact synchronism with that in the camera tube at the transmitter.

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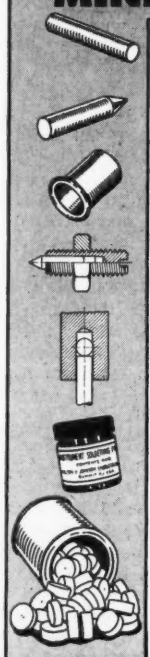

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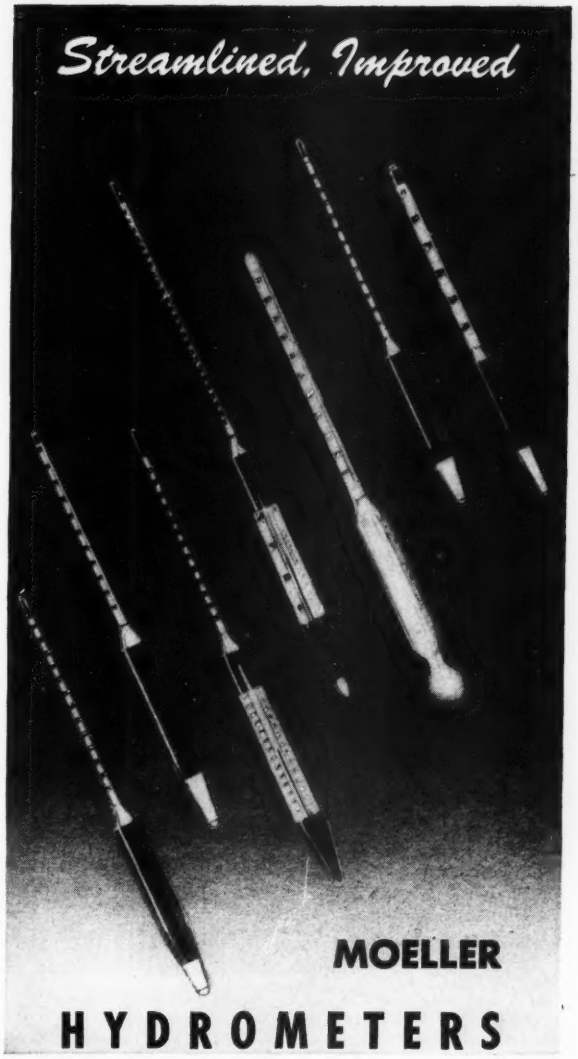

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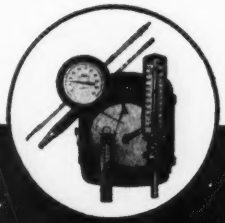

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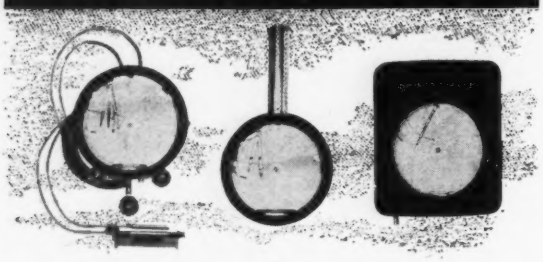

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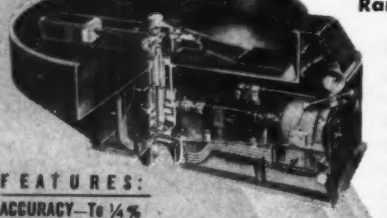

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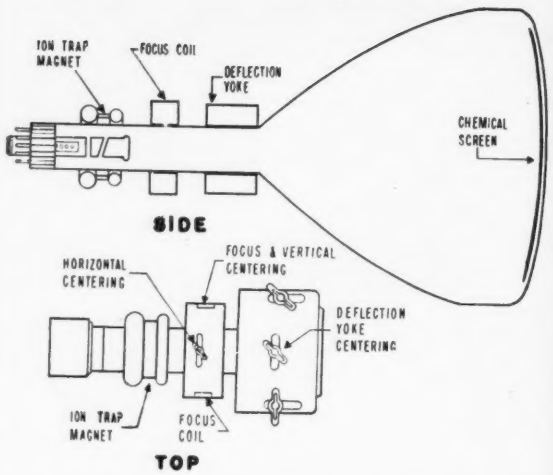

Fig. 13-9. Arrangement of deflection coils, focus coil and ion trap on the neck of a kinescope.

TV Receiver Components

The circuits in television receivers and transmitters are conventional r-f., i-f., video, and audio circuits. The camera tube at the transmitter transfers light intensities into electric signals; the picture tube at the receiver transfers the electric signals back into light intensities.

Kinescope. The picture tube, or kinescope, is a cathode-ray tube which use a conventional electron gun to form a focused beam of electrons (see Fig. 12-7). Electrostatic focusing and deflection systems are used in smaller tubes (up to 7-inch dia.); magnetic focusing and deflection systems are used in larger tubes. Fig. 13-9 shows the placement of focus coil, deflection coils, and ion trap on the neck of a large tube.

Ion trap. The beam produced by any electron gun contains both electrons and ions. As the ions have a large mass compared to electrons, their velocity is low and there is little ion *current* associated with the beam. Therefore, as the deflecting force of a magnetic field depends on beam current, the ions are not affected by the deflecting magnetic field and, if permitted to strike the screen, they would all hit the center of the screen. This would burn the screen at one spot, leaving a brown "ion spot."

The ions are prevented from striking the screen by aiming the electron gun at the side of the tube and by bending the electrons back toward the screen. The bending of the electrons is done by a magnet called an *ion trap,* which is mounted on the neck of the tube.

It is not necessary to use an ion trap in an electrostatic-deflection tube because the deflecting force of an electrostatic field is independent of the mass of the particles in the electron beam. Therefore, the ions are deflected as much as are the electrons and their energy is distributed over the entire screen.

Receiver Circuit

Superheterodyne receivers are used for television reception because of their high selectivity. There are two general types of commercial broadcast TV receivers. One type has one i-f. amplifier for the picture carrier and a second i-f. amplifier for the sound carrier. The second type of receiver, called the *intercarrier-sound* type, uses one i-f. amplifier for both sound and picture. The local oscillator, first detector, and sweep circuits for both types of receivers are almost identical, except that the local oscillator for the former type must be designed to be more stable and free of drift. Fig. 13-10 is the block diagram of a conventional intercarrier-type television receiver.

R-f. section. The a-m. picture carrier and the f-m. sound carrier are received by one antenna. The r-f. section con-

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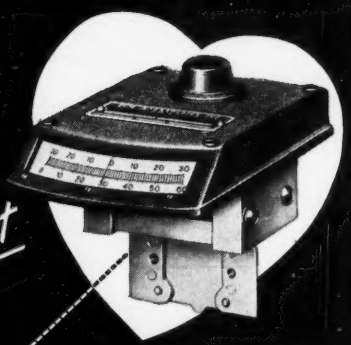

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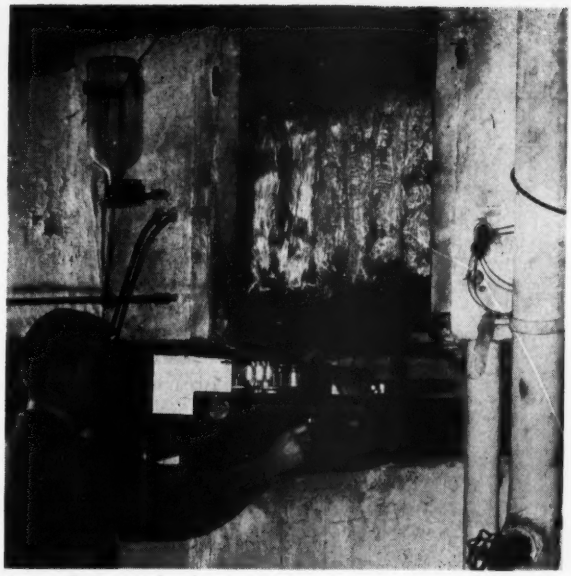

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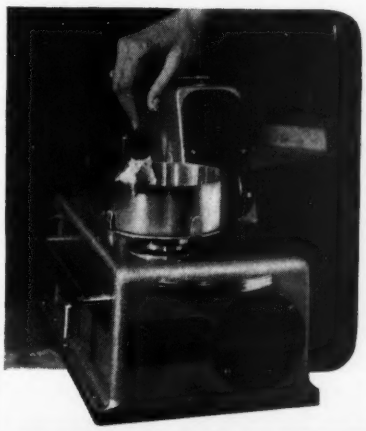

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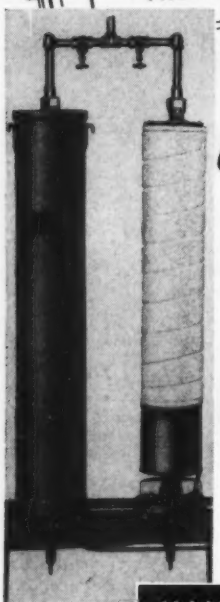

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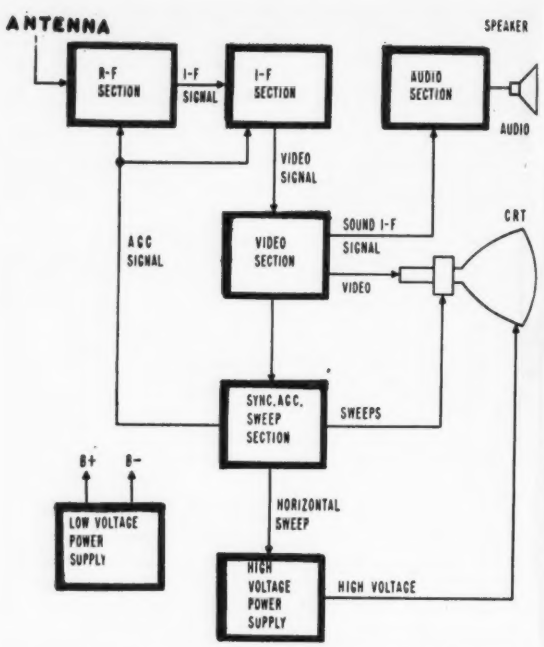

Fig. 13-10. Block diagram of an intercarrier-type television receiver.

tains (1) one r-f. amplifier, (2) a local oscillator, and (3) a mixer, or first detector. The r-f. amplifier stage precedes the first detector and amplifies both sound and picture carriers. The mixer heterodynes the two carriers (sound and video) with the local oscillator. The heterodyning translates the two carriers to their intermediate frequences. In most receivers, the picture i-f. is approximately 26 Mc. and the sound i-f. is 21.5 Mc. Some older broadcast receivers used 12.75 Mc. for the picture i-f. and 8.25 Mc. for the sound i-f. The sound carrier and the video carrier always differ in frequency by 4.5 Mc.

I-f. section. The i-f. amplifier of the intercarrier type receiver amplifies both sound and video i-f. signals. Both amplified signals are fed to the second detector, which is a diode or crystal. This rectifier has two functions—(1) it demodulates the video a-m. i-f. wave into the video-frequency signal for the picture tube and (2) it mixes the sound and video i-f. carriers together, producing a beat frequency of 4.5 Mc. The output of this second detector is the video-frequency (a-m.) signal plus the 4.5-Mc. beat frequency caused by the heterodyning (beating together) of the sound and video i-f. signals in the second detector. This 4.5-Mc signal is the f-m. sound signal. It is recovered by use of a 4.5-Mc. parallel-resonant tank, or "trap," which feeds the audio section.

Audio section. The audio section receives the 4.5-Mc. f-m. signal from the sound "trap." It usually is amplified in one amplifier stage at 4.5 Mc. and then fed directly to a frequency discriminator, such as a Foster-Seeley discriminator or ratio detector; in a few receivers, slope detection of the f-m. sound signal is used. The output of the sound discriminator is a conventional a-m. audio signal, which is amplified by an audio amplifier and then coupled to a loudspeaker through a transformer. It is interesting to note that the sound signal is heterodyned from the radio frequency to the intermediate frequency and then to 4.5 Mc. before it reaches the discriminator.

Video section. The video section usually is only one video amplifier, which has the 4.5-Mc. sound trap in its circuit. The amplified video signal is fed to the grid (or cathode) of the cathode-ray tube, causing the beam to brighten or darken in accordance with the video signal.

Fig. 13-11 shows the video signal going into the video

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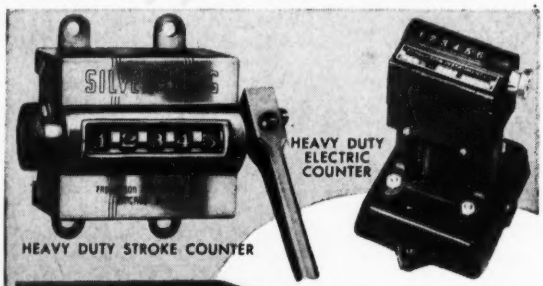

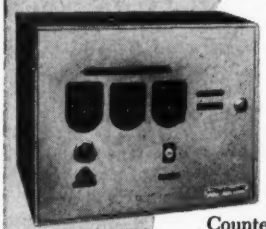

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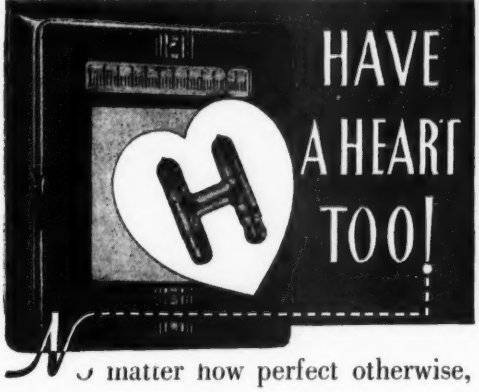

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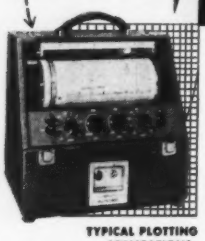

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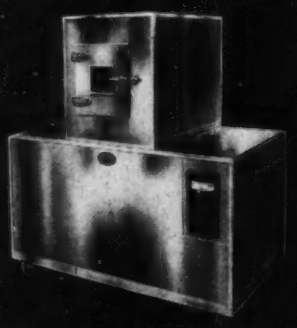

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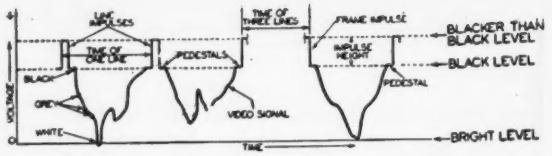

Fig. 13-11. The composite video signal showing synchronizing pedestals and video signals.

section. The same signal, after amplification, is fed to the picture tube. Only the portion of the signal between the "black" and "bright" levels affects the beam brightness; the *pedestal* signals in the "blacker than black" region do not affect the picture because the beam is cut off (blackened) at the black level. These pedestal signals are the sync signals. Each pedestal triggers the horizontal-sweep oscillator (after *differentiation* in the sweep circuit). At the end of 262½ lines, a series of pedestal pulses is *integrated* to produce the sync signal that triggers the vertical-sweep oscillator. The combined video and sync signals shown in Fig. 13-11 are called the *composite video signals.*

Sync and sweep section. The sync and sweep section recovers the sync signals. The sharp leading edge of each pedestal is differentiated in a differentiator to produce a sharp sync signal that triggers a 15,750-*kc. horizontal-sweep oscillator.* The 60-*cps. vertical-sweep oscillator* is synchronized by a signal from an *integrator* that operates only when the series of pulses appear at the end of each field. The two sweep signals are fed to the deflection coils on the neck of the cathode-ray tube, causing the beam to scan across and down the face of the tube in exact synchronism with the scanning procedure in the transmitter.

The *AGC circuit* of the sync section is an *automatic gain control.* This circuit rectifies the video signal and produces a negative voltage that is used to bias the r-f. and i-f. stages so that the amplification of the receiver remains constant even when the signal strength varies.

Power supplies. The low-voltage power supply develops about 300 or 400 volts for the B supply of the amplifier and oscillator stages. The high-voltage power supply develops from 3,000 to 30,000 volts for the accelerating lining of the cathode-ray tube. Voltages of 30,000 volts are required for projection-type tubes. Voltages of about 8,000 volts are required for ten-inch direct-view tubes.

The high-voltage supply is either a radio-frequency supply or a flyback supply. The flyback supply uses the high voltage developed by the rapid current change necessary to produce the horizontal retrace in the magnetic-type deflection circuits. This makes the flyback-type high-voltage supply a part of the horizontal-sweep circuit.

Precautions must be used when handling picture tubes because the accelerating-anode potential is more than 4,000 volts and because dangerous forces exist over the envelope of the tube. For example, a typical 10-inch picture tube has an area of about 250 square inches. Atmospheric pressure exerted over this large area amounts to a force of almost 4,000 pounds. Therefore, the tube should not be struck, scratched, or subjected to more than moderate pressure at any time. Never force it, bump it, use tools near it, or hold it by the narrow neck.

Ghosts

The VHF television signal is reflected from buildings and mountains and sometimes reaches the receiver via several paths. As the time for a spot to make one sweep from left to right is 1/15,750 sec., or about 66 microseconds, and as the speed of the r-f. wave is about 330 yards per microsecond, the distance from left side to right side of the screen represents an r-f. path difference of 330×66 or 21,780 yds. Thus if two signals with a path difference of about 2000 yds. reach the receiver, there appear two side-by-side pictures displaced about 1/10th the diameter of the picture tube.

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TEST ITEMS FOR XIII.—COMMUNICATION AND TV

13-1. The speed of a radio-frequency wave in the atmosphere is about
(a) 300,000 miles per second
(b) 3×10^{10} cm. per second
(c) 330 yards per microsecond
(d) all the above

13-2. Which of the following phenomena are effective for changing the path of radio waves at low frequencies?
(a) reflection only
(b) refraction only
(c) diffraction only
(d) all the above

13-3. Which of the following phenomena affect radio waves less as frequency increases?
(a) refraction only
(b) refraction and diffraction
(c) refraction and reflection
(d) diffraction and reflection

13-4. The ionosphere is produced by high-intensity
(a) radio waves from the earth
(b) heat waves from the earth
(c) radiation from the sun
(d) atmospheric storms

13-5. Most sky-wave long-range communication signals are between
(a) 0.1 and 1 Mc.
(b) 1 and 2 Mc.
(c) 2 and 20 Mc.
(d) 20 and 50 Mc.

13-6. Stations for pushing ground-wave signals across oceans during magnetic storms operate in the
(a) LF band
(b) MF band
(c) HF band
(d) VHF band

13-7. A ground wave is attenuated more rapidly than a sky wave because of
(a) less transmitted power
(b) induced ground currents
(c) antenna inefficiency
(d) atmospheric attenuation

13-8. The advantage of an LF ground wave over an HF sky wave for long-range communication is that the former
(a) has a more efficient antenna
(b) suffers less attenuation during propagation
(c) is unaffected by ionospheric changes
(d) is unaffected by atmospheric changes

13-9. For maximum radiation or reception, the length of an antenna should be
(a) ¼ wavelength
(b) ½ wavelength
(c) 1 wavelength
(d) as long as possible

13-10. The Marconi antenna differs from the Hertz in that the former
(a) is a ½-wavelength antenna
(b) requires a ground plane
(c) is twice as long
(d) radiates vertically polarized waves

13-11. The function of a buffer amplifier in a transmitter is to
(a) isolate the oscillator from the power amplifier
(b) develop a high-power signal for feeding the antenna
(c) modulate the oscillator output
(d) do all the above

13-12. The basic difference between a superheterodyne receiver and a t-r-f. receiver is that the former
(a) has most amplification at the r-f. carrier frequency
(b) has most amplification at the fixed intermediate frequency
(c) has better fidelity
(d) has less selectivity

13-13. The function of the local oscillator in a superheterodyne receiver is to
(a) amplify the r-f. signal
(b) amplify the i-f. signal
(c) change the r-f. signal to an i-f. signal
(d) change the r-f. signal to an a-f. signal

13-14. The advantage of i-f. amplification over t-r-f. amplification is
(a) higher gain per stage
(b) higher selectivity
(c) more constant amplification over the band
(d) all the above

13-15. Which of the following is NOT a characteristic of an image frequency?
(a) It is rejected by r-f. stages in the receiver
(b) It is received when the receiver is tuned to its frequency
(c) It is received when the receiver is tuned to a station that is twice the i-f. away from its frequency
(d) It is important in military radio and radar countermeasures, and also in receiver design

13-16. The advantage of using a t-r-f. amplifier stage in a superheterodyne receiver is
(a) better image rejection
(b) higher receiver sensitivity
(c) prevention of local-oscillator radiation
(d) all the above

13-17. The sound associated with a TV transmission is
(a) transmitted on same carrier as the video signal
(b) an a-m. signal
(c) an f-m. signal
(d) all the above

13-18. One field of a TV picture occurs in
(a) 1/15,000 second
(b) 1/60 second
(c) 1/30 second
(d) 1 second

13-19. Interlaced scanning results in a broadcast TV picture with
(a) 60 lines
(b) 262½ lines
(c) 525 lines
(d) 15,750 lines

13-20. Each TV picture is reproduced at the receiver at a rate of
(a) 525 frames and 60 fields per sec.
(b) 30 frames and 30 fields per sec.
(c) 30 frames and 60 fields per sec.
(d) 60 frames and 60 fields per sec.

13-21. The function of an ion trap on a magnetic-type kinescope is to
(a) bend ions so that they do not strike the screen
(b) bend electrons so that they do strike the screen
(c) bend both electrons and ions away from the screen
(d) bend both electrons and ions so that they strike the screen

13-22. The r-f. section of a television receiver contains one r-f. amplifier, the local oscillator, and the
(a) 2nd detector
(b) i-f. amplifier
(c) video amplifier
(d) video amplifier
(d) mixer

13-23. Which of the following statements about the second detector of an intercarrier-type receiver is NOT true?

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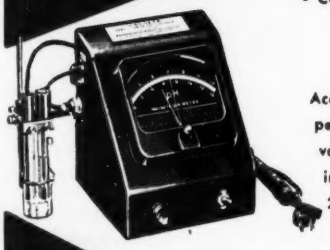

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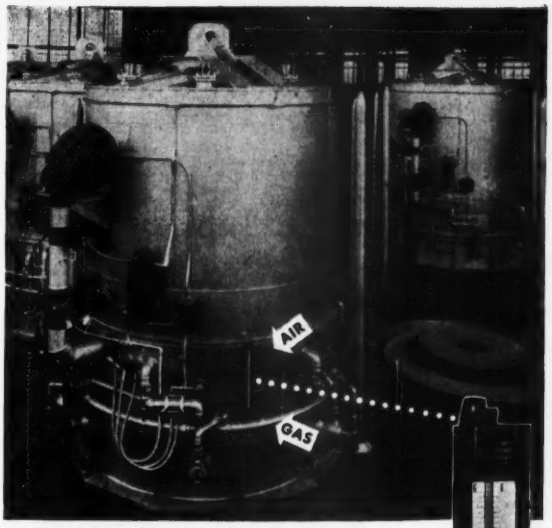

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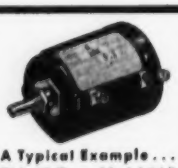

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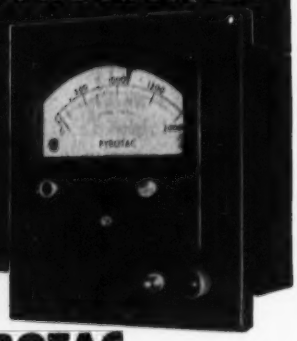

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Alnor PRECISION INSTRUMENTS FOR EVERY INDUSTRY

(a) Its output is the audio-frequency signal
(b) It mixes the sound and video carriers
(c) It demodulates the a-m. i-f. video signal
(d) It is a diode or crystal

13-24. The frequency discriminator of an intercarrier-type TV receiver is tuned to the center frequency of the incoming f-m. signal, which is
(a) 30 cps.
(b) 60 cps.
(c) 15,750 kc.
(d) 4.5 Mc.

13-25. The video signal of a TV receiver is applied to the
(a) grid or cathode of the kinescope
(b) accelerating anode of the kinescope
(c) frequency discriminator
(d) first detector

13-26. The function of the pedestal signals in the composite video signal is to
(a) intensity modulate the electron beam
(b) synchronize the horizontal oscillator only
(c) synchronize the vertical oscillator only
(d) synchronize both horizontal and vertical oscillators

13-27. The TV circuit that produces the horizontal-sweep sync signal is
(a) a differentiator
(b) an integrator
(c) an oscillator
(d) a multivibrator

13-28. The TV circuit that produces the vertical-sweep sync signal is
(a) a differentiator
(b) an integrator
(c) an oscillator
(d) a multivibrator

13-29. The AGC signal of a TV receiver is produced by rectifying the
(a) r-f. signal
(b) i-f. signal
(c) video signal
(d) audio signal

13-30. The TV flyback-type high-voltage supply is a part of the
(a) horizontal-sweep circuit
(b) vertical-sweep circuit
(c) focus circuit
(d) r-f. circuit

PULP AND PAPER INDUSTRY PROBLEMS

Continued from page 1424

direct. Methods utilizing the dielectric properties of paper or the absorption of ionized particles have been used, as well as methods based on the surface temperature of one of the dryer rolls.

A common method has been to measure the inside temperature of a pilot dryer with a bulb inserted through the journal and sealed with a rotary joint. Experiments done a few years ago proved that a temperature measurement of the condensate was more satisfactory. Of course the condensate removal system must be in good working order. In this method the speed of response to roll temperature change was twice as fast as that of a bulb inserted through the journal. The advantage of this was apparent when it was found that the set point of the controller could be left at the same position (about 240 deg. F.) during a paper break without causing more than a 3-deg. hump in the temperature. It had been normal practice for the operator to lower the set point as soon as a paper break occurred, in order to shut off the steam and prevent overheating of the dryers. Suddenly turning the steam on and off in this manner with a steam consumption of 35,000 lbs./hr. was a shock to the steam system and often affected neighboring machines. Another factor was that different operators, after starting the paper through the dryers, turned the steam back on whenever they thought of it, resulting in wet paper. By incorporating reset in the instrument, the dryers were maintained at nearly constant temperature during sudden load changes, such as paper breaks, and the wastage of paper was reduced. Further experiments are going on using a temperature transmitter with derivative action to detect temperature changes still faster and thus reduce offsets during paper breaks.

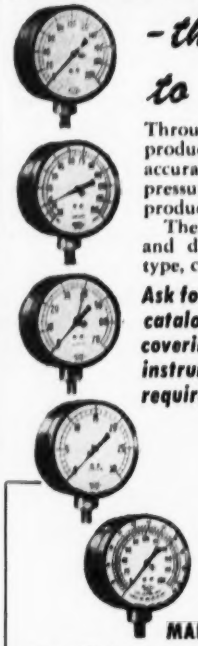
DISCUSSION

Discussor: In regard to level measurement in high-density storage towers, are there any methods to measure stock levels in towers where the consistency is above 30 percent?

Scrivens: As far as I am aware, no one has been able to measure above 20 percent. We are still looking for something for stock level measurement at high consistencies.

Discussor: What are the effects of viscosity on stock flow measurement and stock flow control in the consistency regulator described?

MARSH GAUGES



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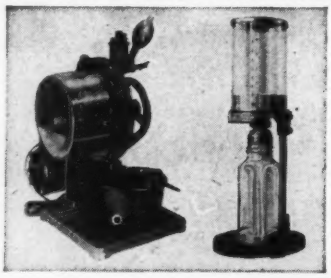

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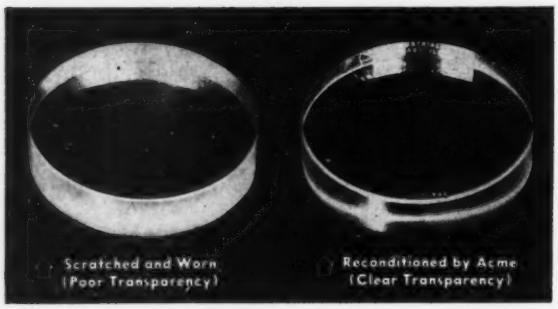

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Scrivens: I used a segmental-type orifice for our stock flow controller on our consistency control set up. The reason is that Venturis, although they have smooth curves and non-plugging characteristics, do not always measure stock flow satisfactorily. What the Venturi does, essentially, is measure variations in consistency along with the pressure differential caused by the fluid flow. In contrast, the segmental orifice plate eliminates this disadvantage. As pressure taps are only one inch on either side of the orifice plate, the pressure variations resulting from consistency changes do not appreciably affect the pressure drop. Although instrument men and paper mill operators are suspicious of any sharp-edged restriction in a stock line, even though there is a lot of pressure on the line, the segmental orifice plate installed for stock flow has a beta ratio as high as posible to minimize the restriction.

Question: Can you use X-ray adsorption on consistency measurement, stock flow measurement, or stock level?

Scrivens: I'm not familiar with these applications. Experimental work has been done on that type of measurement. There has been some work with high-frequency current on consistency measurement and there are several manufacturers of equipment using beta rays for gaging thickness of paper. Light absorption of paper stock in a clear section of pipe as a measure of consistency has also been tried, but I do not know how successful this method has been.

Masal: What can be used as a float in a stock level recorder, and what accuracy is necessary in this level measurement?

Scrivens: The accuracy required for measurement of stock bleaching towers is about 6 inches. It is important to keep the level up to provide sufficient retention time in the tower for maximum chemical reaction. Floats are usually not satisfactory in this application. The reason is that the stock collects and dries on the float, thus affecting its buoyancy.

Discussor: Mr. Mattix wants to know if the consistency control refers to the stock viscosity control.

Scrivens: What is measured is not only consistency but a lot of other things. What we are after is the percent of pulp in the mixture. No direct measurement has been found for measuring consistency and, therefore, we must use an indirect measurement. By measuring the friction drop in the pipe, we are really measuring viscosity changes, and by keeping enough of the variables relatively constant, the apparent viscosity can be related to consistency.

Discussor: Mr. Woods of Honeywell would like to know how to detect moisture content on the paper machine in order to put the control point on the direct temperaure conrols.

Scrivens: As far as I am aware, there are no direct means of continuously measuring the moisture on the paper. Various indirect measurements utilizing conductivity have not been completely satisfactory and the only positive way of measuring paper moisture is by drying it and weighing it to measure the loss in weight. Temperature control of the dryers eliminates the major source of moisture variation of the paper on the machine.

Discussor: Mr. Smith of International Paper wants to know if the plant operators are able to control the consistency satisfactorily for the paper-making operation that follows the stock preparation system?

Scrivens: The consistency in the paper-machine headbox is only a little over ½ percent instead of the 1 to 3 percent that we were talking about. As the curve relating consistency to viscosity flattens out markedly around 1-percent consistency and even reverses its slope at lower values, the equipment I described is not satisfactory at that range. One solution to the problem is that since the stock pumped to the paper machine is diluted from about 3 percent to about 0.6 percent, the volume of dilution water is therefore 4 times the volume of 3-percent stock. Therefore, at constant flow of stock and dilution water, the headbox consistency variations are only 1/5 as great as those in the 3-percent stock. Thus, by measuring and controlling the *flow* of the stock and dilution water, satisfactory consistency control for the headbox stock can be obtained.

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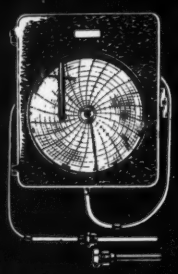

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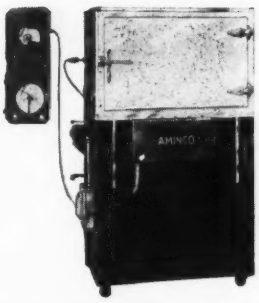

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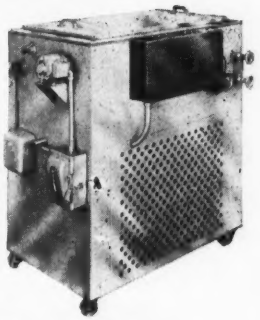

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ORIFICE COEFFICIENTS

Continued from page 1425

the location of the static pressure tap, the orifice ratio (beta), and the differential in inches of water divided by the static pressure in psia.

The steps in determining F_{e2} are: (1) Select an average value of h/P_2 for the meter in question, (2) compute β to two significant figures, and (3) take F_{e2}, for the h/P_2 and β values thus obtained, for flange or pipe taps, from prepared tables.

Determination of F_R

Reynold's factor (F_R) is a correction for turbidity of flow. The value of the Reynold's number for a liquid or gas flowing through a circular section increases with the velocity through the section, with the diameter of the section, with the density of the fluid, and with decrease in the absolute viscosity. The Reynold's number factor depends on the location of the differential pressure taps, the orifice ratio, the internal diameter of the pipe, and the average of the pressure extension ($\sqrt{hP_2}$) obtained from the meter records.

The steps in determination of F_R are: (1) Select an average of $\sqrt{hP_2}$, (2) find S for the correct orifice and tube diameters from tables, and (3) compute F_R by equation:

$$F_R = 1+S/\sqrt{hP_2}$$
$$= 1+S/Mh_8P_{28}$$

Determination of F_{PV}

The deviation factor (F_{PV}) is a function of specific gravity, temperature, and absolute pressure for deviation from Boyle's Law and Charles' Law. First determine Y, the superexpansibility factor for the gas at the flowing temperature, either by experience or by reference to charts or tables. Then

$$F_{PV} = \sqrt{Y}$$

Determination of F_G

The specific gravity of a gas is the weight of a cubic foot of gas compared to the weight of a cubic foot of dry air under the same pressure and temperature conditions.

To determine F_G, the specific-gravity factor, first obtain the specific gravity (G) of the gas from tables. Then

$$F_G = \sqrt{1/G}$$

Determination of F_T

The flowing temperature (T) is the temperature of the gas at the orifice-meter installation in deg. F. abs. The temperature factor (F_T) is

$$F_T = \sqrt{520/T}$$
$$= \sqrt{(460+60)/(460+deg.\ F.)}$$

Tables of this factor are available for rapid determination of F_T.

Determination of M

The square-root-chart factor (M) is

$$M = 0.01\sqrt{R_h R_p}$$

where R_h is the maximum differential range of gage in inches of water and R_p is the maximum pressure range of gage spring in lbs./sq. in. absolute.

Tables are available giving M for various values of R_h and R_p.

TYPICAL PROBLEM

The following table shows the solution to a gas-flow problem. The reference sheet numbers refer to the *SCMA Handbook*, which has tables for rapid determination of the various factors. The *SCMA Handbook* also contains typical solutions for liquid and steam flows.

Conditions at meter	*Value of factor*	*Reference sheet*
Meter equipped with flange taps		
Chart Reading, $h = 40.0$"		
$P_2 = 185.27$ ga.$+14.73 = 200$ psia.		
Orifice diameter = 5.000 inches		
Tube diameter = 8.071 inches	$C = 5530$	194
Expansion factor: $\beta = 5.000/8.071 = 0.62$		
$h/P_2 = 40.0/200 = 0.20$	$F_{e2} = 1.0010$	199
Reynold's Number: $S = .045$ (Sheet No. 197)		
$\sqrt{hP_2} = \sqrt{40\times200} = 89$		
$1+.045/89$ =	$F_R = 1.0005$	
Deviation factor	$F_{PV} = 1.0205$	216
Specific gravity = 0.750	$F_G = 1.1547$	206
Temperature = 100 deg. F.	$F_T = 0.9636$	207

Then $C' = 5530\times1.0010\times1.0005\times1.0205\times1.1547\times0.9636 = 6288$

Quantity $= C'\sqrt{hP_2} = 6288\ \sqrt{40\times200} = 560$ MCF/hour

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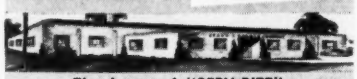

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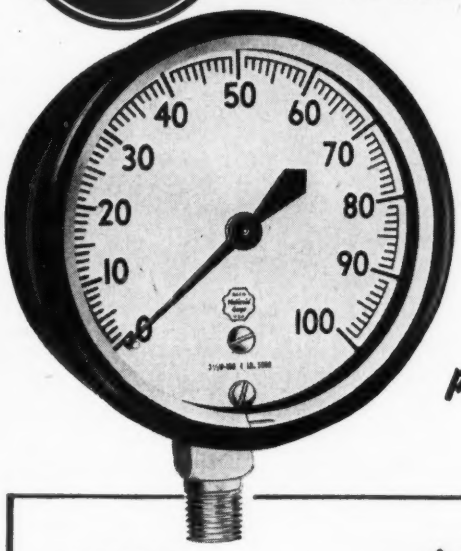

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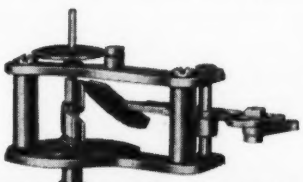

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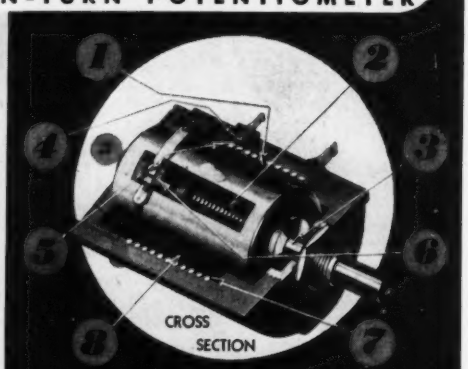

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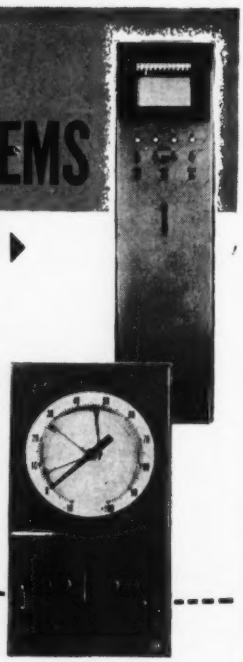

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ELECTROLYTIC CONDUCTIVITY

Continued from page 1419

same as that of the acid being measured and the temperature coefficients compensate. The advantage of the ratio compensation is that the equipment is standard, no calculations or coefficients are required, and the measurement is simplified for automatic control.

Conductivity-measuring Instruments

The instruments generally used for electrolytic conductivity measurements are a-c. Wheatstone bridges, similar to those used for other electrical resistance measurements. They may be manually-balanced indicators or automatically-balanced round- and strip-chart recorders. The Wheatstone bridge circuit is the common four-arm type. Where manually-set temperature compensators are used, the variable resistance compensator is in one arm of the bridge, the measuring conductivity cell is in a second arm, and the third and fourth arms constitute the balancing part of the circuit. Depending on whether one or both of the balancing arms are varied, the scales may be linear or non-linear. The scales may be in either conductivity units or resistance units. In some cases a special compensator is provided in the circuit for cell constant. It is more common, however, for the recorder calibration to be for a definite cell-constant with the cell selected or adjusted to have the proper value.

A-c. rather than d-c. bridges are used to avoid polarization errors. With d-c. or low-frequency a-c., a conduction of current through the solution being measured causes an electrolytic deposition of gas on electrode surfaces. This gas causes resistance readings to increase with time. By using alternating current of 60-cycle or higher frequency, polarization errors are slight. For laboratory measurements of high precision it is necessary to use frequencies of 1000 cycles per second, although this is not necessary for general industrial measurements.

Degasification of Steam Samples

For low-concentration steam measurements it is necessary to correct the measurement for dissolved gases. A more practical arrangement is to degasify the steam sample before measurement. This removes dissolved gases such as ammonia and CO_2, which materially affect readings. Conductivity measurements on a condensed steam sample (to obtain information on carry-over of solids) can be interpreted in terms of dissolved solids. A problem is presented, however, regarding dissolved gases, particularly ammonia and CO_2. To interpret the measurements in terms of dissolved solids, it is therefore necessary to provide means for removing the dissolved gases prior to measurement or to make a correction for them.

Correction factors which may be applied to micromho conductivity read-

ings (when it is desired to estimate the actual conductance due to dissolved solids with ammonia and CO_2 present) can be obtained from approximate tables. For example, an average condensed-steam sample which has a conductivity of 4.2 micromhos might contain approximately 2.5 ppm. of dissolved solids if no dissolved gases are present. If, on the other hand, the solution contains 2 ppm. of CO_2 and 0.2 ppm. of ammonia, the approximate total solids content would be only 1.2 ppm.

As a means for removing the noncondensable gases from a continuous steam or condensate sample prior to conductivity measurements, there are available the "Straub Degassing Condensor" and the "McChesney-Powell Degasser." The "Straub Degassing Condensor" has been used for many years. It consists of a combination condensor and reboiler. The more recently developed "McChesney-Powell" unit uses a simpler arrangement consisting of a small-diameter condensing tube which condenses from a quarter to three-quarters of the steam and discharges into a glass conductivity cell. The combination of steam and condensate causes surface boiling in the cell, boiling off the gases and leaving a condensate practically free of gas at a fixed reference temperature. As the "McChesney-Powell" arrangement is simpler to install, simpler to operate, and lower in cost, it is receiving increased use.

ASST. CHIEF ENGINEER

Wanted by manufacturer of butterfly, slide and gate valves located in Southwestern Connecticut. Must be experienced in designing and estimating valves with manually and automatically operated control mechanisms. Attractive salary and opportunity to assume complete charge in short time. Give full details about your education and experience, to be held confidential. Box 222, Instruments Publishing Co., 921 Ridge Ave., Pittsburgh 12, Pa.

ENGINEER

Synchro Mechanisms

Engineer, with extensive background in design and manufacture of synchro transformers, resolvers and repeaters on full time or consulting basis with well established firm having excellent reputation in another field. Location, Metropolitan New York area. State qualifications. Box 223, Instruments Publishing Co., 921 Ridge Ave., Pittsburgh 12, Penna.

MICRODIAL

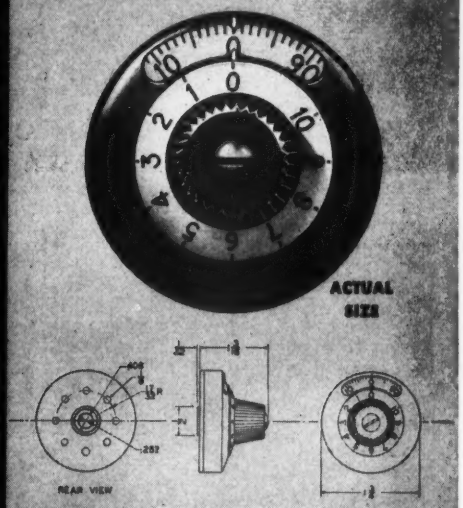
TEN TURN-COUNTING DIAL

Microdial is composed of two concentrically mounted dials . . . one for counting increments of each turn and the other for counting turns. The incremental dial has 100 equal divisions and is attached rigidly to the shaft so there is no backlash. Thus the contact position is indicated to an indexed accuracy of 1 part in 1000. Rotation is continuous in either direction. There are no stops on the Microdial assembly.

COMPACT . . . Microdial has same O.D. as Micropot . . . requires no more panel space.

CLEAR READING . . . Forced fast-reading tests showed only 1/20th as many errors with Microdial open window as with next most legible dial. Turn counter distinguishes between 0 and 10 turn readings, and accelerates to avoid confusion on readings near integral turns. Precise readings are made from larger dial with maximum separation of graduations and wide angle visibility.

CONVENIENT . . . delivered completely assembled with dials synchronized. Easily mounted in a few seconds. All dials may be locked.



Microdial . . . turn-counting dial, primarily designed for use on Micropot ten turn linear potentiometers . . . use it on any multiturn device having ten turns or less.

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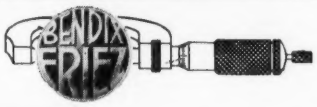

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thermistors

Maybe your need for these temperature responsive resistors can be satisfied by a type we carry in stock. Maybe you require a specially-developed type. In either case you can depend on Bendix-Friez to provide precision-made thermistors to serve you with maximum efficiency. High standards of quality control in manufacture make Bendix-Friez Thermistors pre-eminent in their field . . . assure you of utmost satisfaction.

STANDARD TYPES FOR IMMEDIATE DELIVERY

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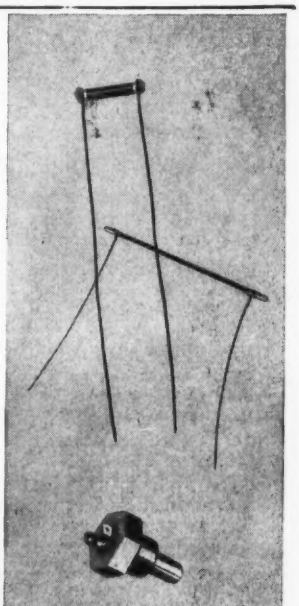
.140 x .75	45.0 ohms	86 ohms	194 ohms
.040 x 1.5	12,250 ohms	26,200 ohms	65,340 ohms
.018 x 1.5	35,000 ohms	82,290 ohms	229,600 ohms

Write for details.



Used in this typical application for sensing the temperature of hydraulic oil.

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Bendix AVIATION CORPORATION

INSTRUMENTS ON THE MARCH

New Principles. Applications. Non-commercial Developments

Electron Microscope

Betty Lucas of the Harshaw Scientific Div., Harshaw Chemical Co., and Lee Sullivan, singing star of Brigadoon, shared interest in the $20,000 electron microscope of North

American Philips Company, Inc., at the Seventh National Instrument Exhibit. One of the significant developments of the ISA Exhibit was the great interest shown in analytical instruments, particularly as applied to industrial processes. Behind Miss Lucas are numerous micrograms taken on the electron microscope.

New Viscometer Uses Ultrasonics

EAST HARTFORD, Conn.—The new "Ultra-Viscoson" uses an elongated metal element excited at an ultrasonic frequency in such a manner that the element shears the liquid in which it is immersed. The ultrasonic waves are damped in accordance with the viscosity and shear rigidity of the liquid.

The probe element is pulsed; the amplitude of vibration is dampened by the medium. When the amplitude falls to a given point (based on the area under the curve—that is, an integrated signal) the element is pulsed again. Thus the element is pulsed at a high rate in a viscous medium and at a low rate in a nonviscous medium. The frequency, or rep. rate, is used as a basis of measurement of viscosity.

An electronic computer automatically and continuously solves the equation relating fluid properties to *damping* of the vibrating element so that

$$\text{Reading} = (\epsilon/\omega_o)\,(\sqrt{g^2+\beta^2\eta^2}+g),$$

where ϵ is the density of liquid in gm./cc., ω_o is the constant of the system, g is the rigidity coefficient of liquid in dynes/cm.^{2}, η is the viscosity coefficient of liquid in poises, and β is the frequency employed.

For the majority of liquids, the rigidity is less than 10^5 dynes/cm.^{2} and, therefore, is completely negligible compared with $\epsilon\eta$, the product of frequency (30,000 cps.) and viscosity. Therefore, reading is a measure of $\epsilon\eta$. The "Ultra-Viscoson" is made by the Ultra-Viscoson Corp., Hartford 3, Conn.

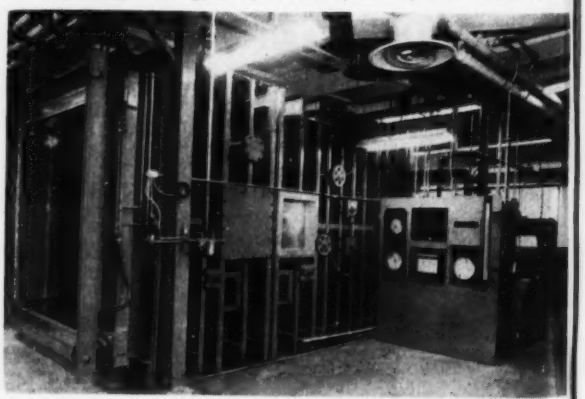
Radioactivity Tests Road Materials

PHILA., Pa.—A technician of The Atlantic Refining Company, Philadelphia, Pa., uses a General Electric scintillation counter to test quality and adhesive characteristics of asphalt which will be used in the making of roads.

Typical road stone is soaked in radioactive calcium chloride, dried, coated evenly with asphalt, and then covered with water for a specified time. If the asphalt separates from the stones, the calcium chloride dissolves. After evaporation, the radioactivity of the residue is measured with the counter. A correlation between radioactivity count and previously prepared charts tells Atlantic engineers the quality and adhesive characteristics of the asphalt.

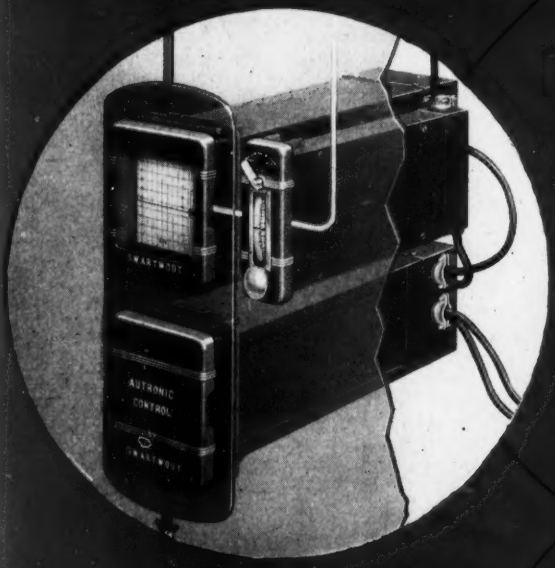
Artificial Weather

AKRON, Ohio.—The Goodyear Aircraft Corporation, Akron, Ohio, recently installed a specially designed 440-cu.-ft. environmental test chamber for testing aviation equipment and instruments under weather conditions more severe than those found in the arctic and the tropics and equaling those found at altitudes up to 75,000 ft. Manufactured by Tenney Engineering, Inc., Newark, N. J., the chamber is

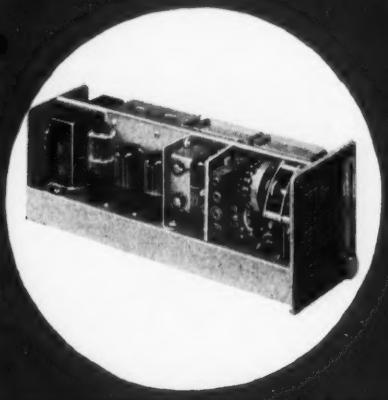


Swartwout Autronic Control System

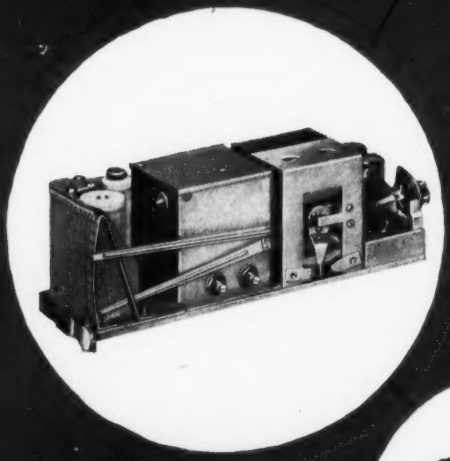
ACCURATELY AND INSTANTANEOUSLY MEASURES, RECORDS, AND CONTROLS PROCESS VARIABLES



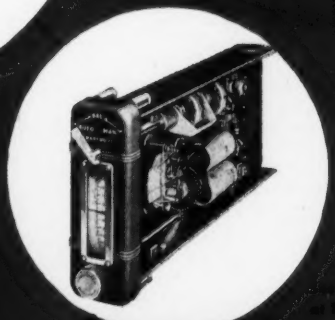
1 Completely revolutionary, the Autronic Control System is the *first miniature all-electronic centralized control system.* Signal transmission throughout system is by electrical means only—right from primary element to final element. This means that control is positive and accurate because there are no transmission lags . . . no boosters, slide wires, motors . . . no air lines to leak, corrode or freeze up. Autronic controller can be located at any point. Cable length unimportant with highest accuracy maintained over distances of over 1000 feet.



2 AUTRONIC CONTROLLER *(case removed)*—Infinite sensitivity is provided by completely eliminating all mechanically moving parts. Proportion, reset, and rate-action adjustments; direct or reverse acting. Model shown has set-point. When used with Autronic Recorder, setpoint is on recorder.



3 AUTRONIC RECORDER *(case removed)*—Has no slide wires or connecting mechanisms. Pen writes on curved edge of chart with same radius as pen arm to give *true linear trace.* Double-sprocket drive. Holds 1-month paper supply. Three-position response-speed adjustment.



4 MANUAL CONTROL *(case removed)*—Edge-reading dial calibrated from 0 to 100 continuously adjusts control output. With changeover switch in balance position, dial reads difference between controller and manual outputs. Fast "bumpless" changeovers made by adjusting manual or automatic output to center-index line.

See the Autronic Control System on display at Booths 322 and 324, 7th National Instruments Exhibit, Cleveland, September 8-12th.

Swartwout *Autronic*

THE SWARTWOUT COMPANY • 18511 EUCLID AVENUE • CLEVELAND 12 • OHIO

ASCO HEADQUARTERS FOR SOLENOID VALVES

3 *Presents*

SMALL GENERAL PURPOSE PACKLESS SHUT-OFF VALVES

for

AIR, GAS, WATER, STEAM, LIGHT OILS, REFRIGERANTS AND OTHER LIQUIDS

With 7 **BIG CONSTRUCTION FEATURES:**

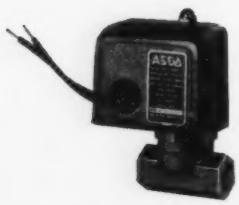
1. Heavy duty construction—only one operating part, and that of stainless steel—insures millions of trouble free operations.
2. Continuous operating speed over 400 cycles per minute.
3. Forged or bar stock brass and stainless steel construction assure freedom from porosity, a prime requirement for high vacuum or liquefied gas applications.
4. Internal parts readily accessible without removing valve body or disturbing electrical connections.
5. Large size conduit boxes can be rotated 360° in plane parallel to pipe line.
6. Positive bubble-tight shut-off with resilient or metal seating.
7. Low power consumption. Continuous duty coils will not overheat.

These three valves are but samples of the comprehensive line offered for instrument control. To thousands of satisfied users, "ASCO" and "Solenoid Valves" are synonymous.

BULLETIN 8262
MIDGET SOLENOID VALVE
Normally closed or normally open
Standard Voltages: 115, 230 or 440 A-C
60 cycles; 115 D-C

Body Material		Brass or Stainless Steel			
Pipe Size (inches)		1/8		1/4	
Port Diameter (inches)		7/16	1/8	5/32	7/16
Maximum Pressure lbs sq. in	A-C	300	130	90	60
	D-C	250	70	50	30

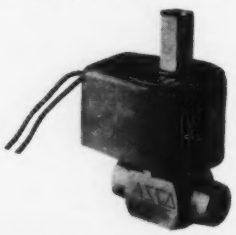
Bulletin 8262 Solenoid Valves may be obtained with by-pass and metering devices. EXPLOSION PROOF AND WATER PROOF HOUSING AVAILABLE. Valves may be installed in any position. Modified Bulletin 8262 Valve with Time Delay can be supplied. Write for literature.



BULLETIN 8265
SOLENOID VALVE
Normally closed
Standard Voltages: 115, 230, 440 A-C
50 or 60 cycles; 115, 230 D-C

Body Material		Brass or Stainless Steel		
Pipe Size (inches)		3/8		
Port Diameter (inches)		1/8	3/32	1/4
Maximum Pressure lbs sq. in	Air and non-corrosive gases	250	125	35
	Water, steam non-corrosive liquids to 70 S. S. U. viscosity	175	110	35
	Oil and liquids to 70 S. S. U. viscosity	150	80	30

Bulletin 8265 Solenoid Valves are supplied with stainless steel or resilient type seats—positive seating is assured with either. Standard solenoid housings are for NEMA Type 1 requirements; watertight NEMA Type 4 Housings can be supplied. For steam service, valves are supplied with Class H high temperature glass silicone insulated coils. Send for literature.



BULLETIN 8314
3-WAY SOLENOID VALVE
Standard Voltages: 115 or 230 A-C
60 cycles; 115 D-C

Body Material		Brass or Stainless Steel
Pipe Size (inches)		1/8
Port Diameter (inches)		3/16
Max. Pressure lbs. / sq. in.	A-C	125
	D-C	50

Bulletin 8314 valves may be applied to any 3-way valving requirement regardless of flow directions or pressure application points. The standard valve without any change of springs or other adjustments is suitable for any 3-way control application. These valves may be mounted in any position and will give positive tight shut off. Send for literature.

We also manufacture a quality line of specialized controls including Automatic Transfer Switches, Remote Control Switches, Contactors and Relays.

Automatic Switch Co.

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Ad. No. V-53-8

designed to produce temperatures ranging from minus 100 to plus 200 deg. F.; humidity from 20 to 95 percent; and vacuum pressures from 30 in. of mercury absolute to 1 in. of mercury absolute. Pressure can be brought from sea level to 1 in. mercury (75,000-ft. altitude) in 20 min. Specified "pull-down" is from room temperature to minus 100 deg. F. in 90 min. when containing a mass of 1000 lb. It is planned to dissipate operating loads as high as 3 kw. at temperatures as low as minus 100 deg. F. At times the chamber will be called upon to dissipate these heavy heat loads continuously over 10-day test periods.

In addition to the variable temperature, humidity, and altitude provisions (all may be varied independently of each other), the chamber is equipped with two 3,000-rpm. power shafts and two terminal pads so that mechanical and electrical equipment may be operated from the outside and tested under actual operating conditions.

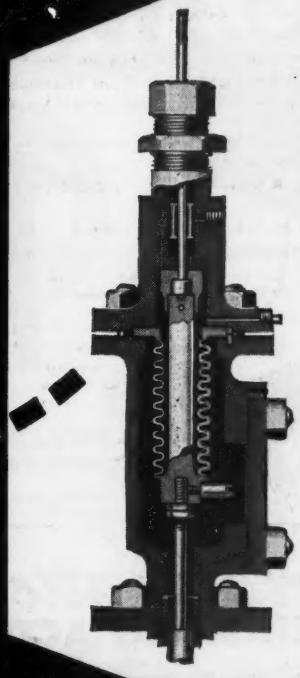
Air-filter Efficiency

LOS ANGELES, CALIF.—Announcement of an improved method for testing air filter efficiencies has just been released by Farr Company, Los Angeles, California. Previously, filter efficiencies were determined by laboratory methods using a "standard" test dust. The new method tests each filter according to dust particle size. From the efficiency table thus obtained, the performance of any filter can be pre-determined for any operating condition. This advanced method allows a user to buy the filter which performs at the correct efficiency for the job to be done.

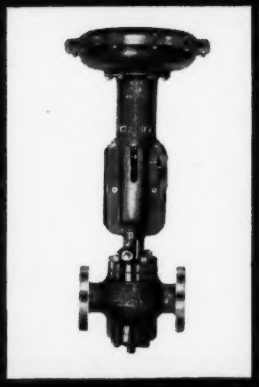
Micromanipulator

WASHINGTON, D. C.—A micromanipulator recently constructed at the National Bureau of Standards combines moderately high precision with simplicity, ruggedness, and low cost. Devised by Fred Ordway of the Portland Cement Association at the National Bureau of Standards, the new micromanipulator is shown being used with a binocular microscope to facilitate the mounting and grinding of small crystal specimens. The micromanipulator consists of a heavy base plate, two adjustable manipulators for holding miniature tools, and a three-legged platform for supporting specimens in proper relation to the tools. Raising or lowering of corners of the triangles, by means of adjusting screws,

POSITIVE PROTECTION . . .



prevents dangerous or costly leakage



The bellows seal of the Honeywell Series 700 Valve is a metal barrier which insures against loss of valuable or dangerous fluids . . . cannot buckle or twist . . . is precision-machined . . . takes pressures up to 600 pounds. The Honeywell Series 700 wide band proportional control valve comes in a full range of styles and sizes . . . has *all* the features you look for in a fine valve. Write today for your copy of Bulletin 700-2.

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Honeywell
VALVE PRODUCTS

H HONEYWELL

First in Controls

THERE IS NO FASTER
OR BETTER WAY TO MAKE TEST
CONNECTIONS THAN OFFERED BY
THE SIMPLIFIED GRAYHILL PANEL
MOUNT, SPRING PRONG CLIP AND
THE GRAYHILL FULLY INSULATED,
TIGHT-GRIP TEST CLIP.
Ask for Samples.

Panel Mount Type No. 2-0

Insulated Alligator Type
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FLARING TOOL

Makes correct 45° S A E flares. Goes far beyond ordinary flaring tools in quality of flare and ease of operation.

Automatically Burnishes Flares

A lost-motion-mechanism causes its multi-faced flaring cone to burnish flare automatically giving flare a highly polished finish which assures tighter joints.

Makes Stronger Flares

Because flare is not formed against die block, original wall thickness is maintained at base of flare . . . stronger flares are assured.

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No. 500-F ROL-AIR FLARING TOOL flares and burnishes 3/16", 1/4", 5/16", 3/8", 1/2", 5/8" O.D. tubing..$9.25 each

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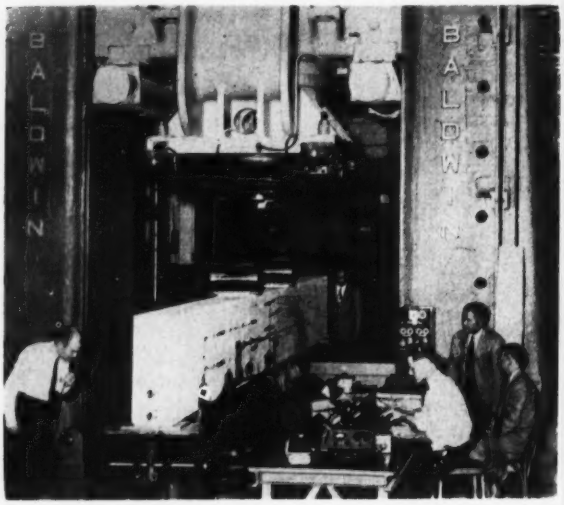
results in practically horizontal motion of the microtools in the small working region. The present model has a sensitivity of 0.08 centimeter per turn and a maximum travel of about 2.5 cm.

Concrete-beam Tests

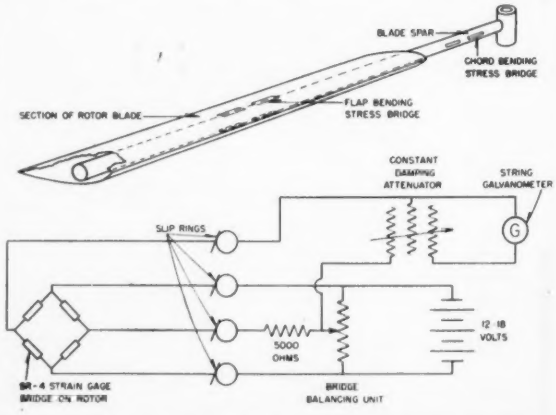
DENVER, COLO.—Extensive tests of a 25-ft. reinforced concrete beam at the Bureau of Reclamation, Denver, Colo., were concluded recently using the largest testing machine in the United States. After hundreds of measurements



made by various instruments, including Baldwin SR-4 resistance-wire strain-gages bonded on the sides of the beam and to the embedded reinforcing steel, the beam was stressed to failure at 229,000 lb. under two-point loading. Maximum deflection was 2 inches.

Helicopter Instrumentation

The measurement of strains in helicopter rotor blades while in flight is among the routine procedures now used at Piasecki Helicopter Corporation for checking the performance of new types and sizes of rotors against their de-



sign strength and the actual maximum stresses to which they may be subjected in flight. At each strain-measuring station on the helicopter rotor blade, four SR-4 resistance wire strain gages are connected as a Wheatstone bridge. There are two gages on each side of the blade or spar. Each wire from the bridge runs through a slip ring on the rotor shaft, and down through the transmission mechanism into the helicopter cabin to individual bridge-balancing units. From the balancing unit the signal goes to a galvanometer element in a multichannel recording oscillograph.

FOR NEW BUSINESS FROM OVERSEAS–

wise manufacturers and exporters everywhere use an international journal—for none other has the pulling power of a publication which penetrates into all world markets.

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To readers of this advertisement whose interests lie in import rather than export, we extend a cordial invitation to subscribe to the OVERSEAS EDITION. Every issue is packed with up-to-date technical information on new machines and processes and contains a digest of industrial news from our own correspondents in Overseas markets. The subscription fee is $7.00 for 26 issues a year.

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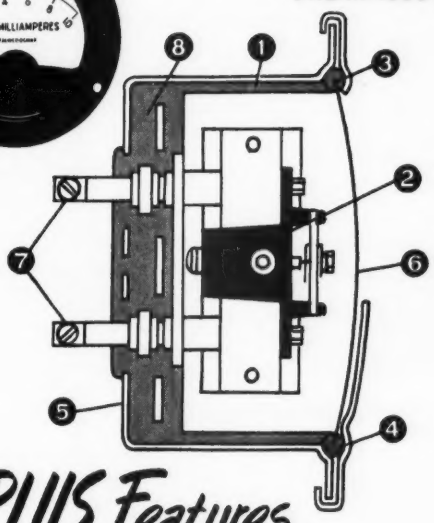
RUGGEDIZED METERS

...TO MEET SIG. C. SPEC. **MIL-M-10304**



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Extra "Ruggedized" Features

1. Meter movement completely shock-mounted and housed in rubber-lined case.
2. Meter movement supported by die-cast frame for greater strength and increased accuracy.
3. Observation window rubber grommeted and sealed to rubber lining of case—providing hermetical seal of high dielectric materials.
4. Non-rigid mounting of observation window with rubber grommet increases resistance to shock.
5. Each meter designed and built by SUN to highest quality and precision standards.

Extra Installation Advantages

6. Slight convexity of observation window reduces chance of accidental breakage during installation or shipment.
7. Terminals side-tapped and provided with tinned binding screws to facilitate wiring with or without wire lugs or by pressure, soldering or both.
8. Breakage or damage in wiring is reduced through non-rigid mounting of terminals and use of flexible interior conductors.

Building rugged electric meters is not new to SUN . For over 20 years, the automotive industry has depended on SUN as one of the largest "D'Arsonval-type" meter manufacturers—to produce rugged, tough meters that will stand up under the abuse and rough handling of portable field instruments used in automotive repair work. SUN "Ruggedized" Meters not only meet Specification MIL-M-10304 (Sig.C.)—but also embody many *plus* features that make installation easier, faster and help prevent assembly or shipping damage. Complete data bulletin on SUN "Ruggedized" Meters available on request.

SUN "Ruggedized" Meters are available as D-C Volt Meters, Ammeters, Milli-ammeters and Micro-ammeters and also may be ordered as rectifier type A-C instruments.

SUN ELECTRIC CORPORATION

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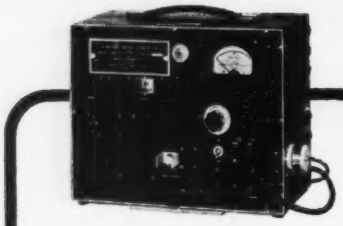

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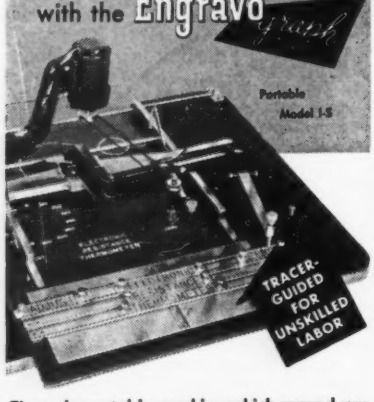

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Manufacturers' New Literature

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Requests for literature FROM ABROAD should be made on company letterhead and mailed DIRECTLY to the manufacturers.

Temperature

U-967 **Optical Pyrometer.** 8-page Catalog 85 illustrates and describes maker's self-contained, direct-reading optical pyrometer. Includes principles of optical pyrometry, discussion of emissivity, and features of pyrometer.—The Pyrometer Instrument Co., Bergenfield, N. J.

U-968 **Temperature Control.** 4-page brochure "Instrument Section 55" illustrates and describes maker's resistance-bulb-type temperature controllers with signaling feature. Includes principle, features, and applications. Resistance bulbs are described in 2-page Bulletin 55-5.—Thermo Electric Co., Inc., Fair Lawn, N. J.

U-969 **Plastic-sheathed Pyrometer Wire.** 4-page Catalog 12 illustrates and describes new line of plastic-sheathed thermocouple wires and new rust-proof thermocouple head. Includes features. 2-page brochure illustrates and describes 41 types of thermocouple lead wires with various insulations.—Industrial Pyrometer Supply Co., Alton, Ill.

U-970 **Cold-test Cabinets.** 8-page illustrated brochure presents maker's large line of wide-range temperature testing units and industrial freezers. Includes features and specifications of 42 models.—Webber Appliance Co., Inc., 2740 Madison Ave., Indianapolis 3, Ind.

U-971 **Heat Processing.** 12-page August issue of "High Gradient" contains seven short articles on use of heat in removing oil from air, in welding bicycle frames, in manufacturing TV tubes, etc.—Selas Corp. of America, Phila. 34, Penna.

U-972 **Flexible Heating Wire.** 4-page issue 48 of "Chromalox News" illustrates and describes application of "Thermwire" electric heating wire in sidewalks, in molding, welding, bending plastics, etc.—Edwin L. Wiegand Co., 7500 Thomas Blvd., Pittsburgh 8, Penna.

U-973 **Flexible Heating Tape.** 2-page Circular 552 illustrates and describes three kinds of flexible heating tapes and bands—"Standard" for heating small glass vessels, "Extra Insulated" for hard usage, and "Band Type" for transfer lines. Includes prices and specifications.—Scientific Glass Apparatus Co., Bloomfield, N. J.

Pressure and Vacuum

U-974 **Manometers.** 4-page illustrated brochure on maker's "Red Line" manometers includes well-type manometers, absolute-pressure manometers, U-tube manometers, indicating flowmeters, orifice flanges, and orifice plates.—Trimount Instrument Co., 3119 W. Lake St., Chicago 12, Ill.

U-975 **Vacuum Manifold System.** Illustrated data sheet describes unit designed for evacuating and back-filling small containers like sealed relays, ten at a time. When combined with helium-sensitive Consolidated Leak Detector, vessels in vacuum may be probed with a jet of helium while diffusion pump is evacuating them. Capacity, ports and valves, pumps, gauges, installation, and specifications are included.—Distillation Products Industries, Eastman Kodak Co., Rochester 3, N. Y.

U-976 **Leak Detector.** Illustrated data sheet describes "Halogen-sensitive Leak Detector Type LD-01" which reveals leaks in high-vacuum systems by responding to small traces of probe gases. Probing procedures, installation, and maintenance data are included.—Distillation Products Industries, Eastman Kodak Co., Rochester 3, N. Y.

Pressure Control

U-977 **Hydraulic-press Pressure Control.** 8-page Vol. 3 No. 5 issue of "The Denison Multi-Press" features article on pressure control in hydraulic press. Also articles on use of presses in marking, pressing, and blanking.—The Denison Engineering Co., Dublin Rd., Columbus 16, Ohio.

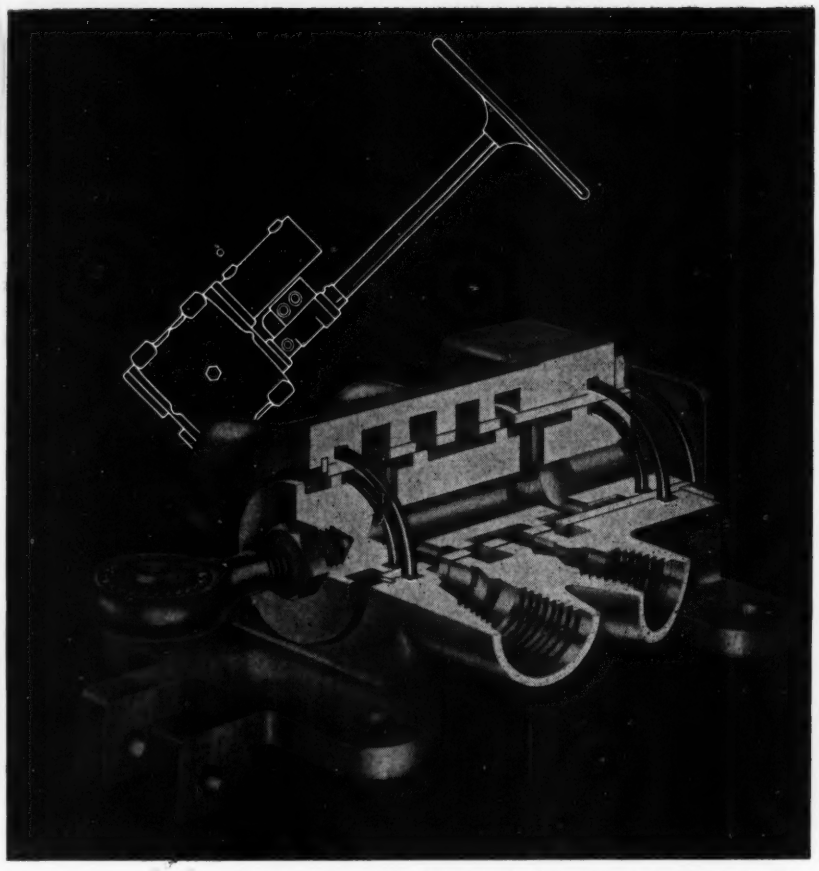
Flow

U-978 **Variable-area Flowmeters.** 4-page Bulletin 1038 illustrates and describes maker's new "Type 12" multiple-stage flowmeters with extended ranges from 4 to 61,000 pounds per hour. Includes features and capacity chart.—Commercial Research Labs., Inc., 20 Bartlett Ave., Detroit 3, Mich.

Industrial Instrumentation

U-979 **Industrial Instrumentation.** 40-page Vol. 6 No. 2 isue of "Instrumentation" features aritcles on White-house air-conditioning control, medical-plant instrumentation, power-plant instrumentation, resistor-plant instrumentation, annealing control, characteristics of Teflon, and others.—Industrial Div., Minneapolis-Honeywell Reg. Co., Phila. 44, Penna.

U-980 **Industrial Instrumentation.** 28-page Vol. 4 No. 4 issue of "Taylor Technology" features articles on instrumentation and process control of asphalt process, photographic-paper dry-



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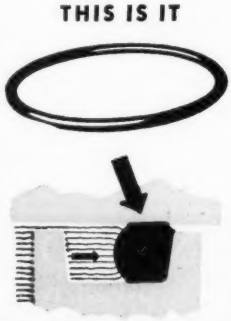

Cross section drawing of O-ring in groove, sealing under pressure.

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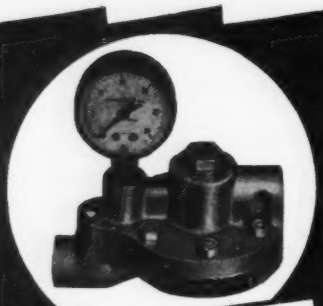

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NEW LITERATURE

ing, pharmaceutical-chemical process, etc. Included is article "Frequency and Transient Analysis of a Rate Action (Pre-Act) Controller."—Taylor Instrument Companies, Rochester 1, N. Y.

U-981 **Index of Instrumentation Literature.** 24-page Bulletin Index 100-A is index of technical literature available from Honeywell's Industrial Division. Contains numerical listing and alphabetical cross index for specification sheets, instrumentation data sheets, catalogs, and other literature. Included in alphabetical index are articles from "Instrumentation," the manufacturer's quarterly publication.—Sta., 40., Minneapolis-Honeywell Reg. Co., Phila. 44, Penna.

U-982 **Electronic Process Recorder.** 6-page Bulletin A-704 illustrates and describes maker's "Autronic" miniature all-electronic recorder for use in processing plants, refineries, etc. Includes principles and block diagrams.—The Swartwout Co., 18511 Euclid Ave., Cleveland 12, Ohio.

Controllers

U-983 **Electronic Control Equipment.** 6-page bulletin A-702 illustrates and describes "Autronic" electronic process-control and power-plant equipment. Includes principle, block-diagram, dimensional drawings, etc.—The Swartwout Co., 18511 Euclid Ave., Cleveland 12, Ohio.

U-984 **Contact-making Automatic Controllers.** 4-page Bulletin CMR-79 presents detailed specifications of "Simply-trol" contact-making electrical indicating instruments.—Assembly Products, Inc., Chagrin Falls 1, Ohio.

U-985 **Edge-position Control.** 4-page Bulletin 141 illustrates and describes control system, for positioning edge of moving web material, comprising noncontact sensing nozzle, hydraulic jet-pipe regulator, and power cylinder. Includes features and components.—Askania Regulator Company, 240 E. Ontario St., Chicago 11, Ill.

U-986 **Electro-hydraulic Power Amplifier.** 2-page Bulletin 157 illustrates and describes new "Electro-jet" power-amplifier that uses motor to position jet of hydraulic power-amplifier. Includes features and response curves.—Askania Regulator Co., 240 E. Ontario St., Chicago 11, Ill.

Speed and Vibration

U-987 **Vibration Measurement.** 4-page illustrated Bulletin CEC-1505 B describes maker's "Type 1-110B Vibration Meter" for measuring velocity of motion and peak-to-peak displacement, linear or torsional. Includes features, specifications, operation, pickups, and accessories.—Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 8, Calif.

U-988 **Vibration Pickup.** 6-page illustrated Bulletin 124 C describes maker's pickup for measurement of all modes of rotational and reciprocating vibrations. Includes principles, features, specifications, and models.—The MB Mfg. Co., Inc. 1060 State St., New Haven 11, Conn.

U-989 **Vibration Control.** 12-page Bulletin 410 B deals thoroughly with problem of vibration control and presents maker's vibration and shock mounts. Includes problem analysis, selector chart, and descriptions of vibration exciters and pickups.—The MB Mfg. Co., Inc., 1060 State St., New Haven 11, Conn.

U-990 **Portable Tachometers.** 2-page Technical Data Sheet 48HJK illustrates and describes maker's "Types 48H, 48J, and 48K" portable tachometers for speed measurement.—Metron Instrument Co., 432 Lincoln St., Denver 9, Colo.

Level

U-991 **Liquid Level Control.** 4-page Vol. 4 No. 1 issue of "The Rambler" announces new "Autocon Bubbletrol" which uses no floats or electrodes. Also discussed is problem of controls for elevated tank systems.—Automatic Control Co., 1005 University Ave., St. Paul 4, Minn.

U-992 **Remote-reading Level Gage.** 4-page Bulletin CP 3001 introduces new "Varec" electronic remote-reading liquid-level gaging equipment. Includes features and typical installation.—The Vapor Recovery Systems Co., Compton, Calif.

Weight

U-993 **Precision Balances.** 4-page illustrated bulletin describes "Metrogram" precision balances, electronic and mechanical, for laboratory and industrial weighing. Includes models, features, and prices.—Arthur S. LaPine & Co., 6001 S. Knox Ave., Chicago 29, Ill.

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U-994 **Automatic Filling Scale.** 2-page catalog sheet illustrates and describes new "Model 400N" filling scale that bags bulk materials within 0.1 lb. in range from 25 to 200 lbs. Includes features, performance, and specifications.—Thayer Scale & Engineering Corp., E. Water St., Rockland, Mass.

U-995 **Scales.** 24-page September, 1952 issue of "Esso Oilways" features 6-page article on scales which indicate from as little as 0.0625 ounce to as much as loaded freight cars, manufactured by Howe Scale Co., Vt. Other articles are on nitrogen products, catalytic incineration of waste gases, and water-washed bearings.—Esso Standard Oil Co., 15 W. 51 St., New York 19, N. Y.

Radioactivity

U-996 **Density Gage.** 4-page Bulletin 104 introduces new applications of radioactivity-detector cell and a null-measuring system for measurement of density, liquid level, coating thickness, particle size, etc., in industrial-process instrumentation. Includes principles, features, and typical applications.—The Ohmart Corp., 2347 Ferguson Rd., Cincinnati 38, Ohio.

U-997 **Scintillation Equipment.** Illustrated data sheets contain descriptions, features and advantages of (1) new scintillation converter for using scintillation counter with geiger scaler, (2) scintillation scalers for scintillation, Geiger, or proportional counting, and (3) complete portable scintillation detection unit.—Nuclear Research & Development, Inc., 1094 Sutter Ave., St. Louis 5, Mo.

U-998 **Pipette for Radioactive Materials.** Illustrated data sheet gives features and specifications of "Model RC-1 Remote Pipette Control" for remote handling of radioactive solutions.—Nuclear Research & Development, Inc., 1094 Sutter Ave., St. Louis 5, Mo.

U-999 **Gamma Detection.** 4-page Bulletin 103 illustrates and describes 4 models of radioactivity-detection cells and typical applications in monitoring gamma radiation. 4-page Bulletin 102 covers "Series AH" Gammometer for direct measurement of gamma radiation.—The Ohmart Corp., 2347 Ferguson Rd., Cincinnati 38, Ohio.

U-1000 **Pocket Dosimeters.** 4-page Form 3012 illustrates and describes maker's complete line of pocket dosimeters for civilian and military use, radiologists, etc. Includes features and specifications of seven models and two charger-readers.—The Victoreen Instrument Co., 5806 Hough Ave., Cleveland 3, Ohio.

U-1001 **Radioactivity Detector.** 4-page Bulletin 101 illustrates and describes the "Ohmart" radioactivity-detector cell that used no high-voltage supply. Includes principle and typical application.—The Ohmart Corp., 2347 Ferguson Rd., Cincinnati 38, Ohio.

Testing and Inspection

U-1002 **Surface Flatness.** 4-page "Optical Straightedge" Catalog 20 describes and illustrates new system for measuring surface flatness by means of optical levels that utilize a beam of light as a straight line reference, and stylus and microscope to draw a profile

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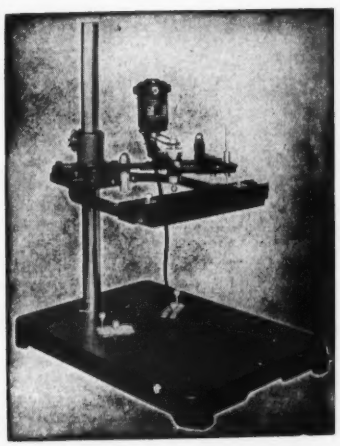

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NEW LITERATURE

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U-1003 **Surface Comparator.** 4-page illustrated Bulletin 3M presents new "Kota-Meter Surface Comparator" for examination of surface finish to 1 microinch. Includes principle, features, and specifications.—Kota-Meters, Inc., 2311 Burbank St., Dallas 19, Texas.

U-1004 **Force, Strain, Surface Finish, etc.** 4-page Bulletin A-103 illustrates and describes maker's line of industrial instruments for measurement of force, strain, displacement, etc. with differential transformers, strain gages, etc. 2-page Bulletin T-137 presents the "Myke-A-Trol" unit with relays for control application.—Industrial Electronics, Inc., 8060 Wheeler St., Detroit 10, Mich.

U-1005 **Strain and Tension.** Illustrated Sheet 3 describes maker's ring dynamometers for tension and compression testing. Sheet 8 presents "Bar Type Strain Gage GB-8" for strain measurement.—Ann Arbor Instrument Works, Ann Arbor, Mich.

U-1006 **Quality-control Manual.** 40-page illustrated booklet contains terminology, techniques, tables, computations, and calculating-machine methods for statistical quality control.—Monroe Calculating Machine Co., Inc., Orange, N. J.

U-1007 **Impact Testers.** Illustrated Brochure 523 describes new low-capacity impact-testing machine for plastics, ceramics, and light metals. Includes features, construction, and operation.—National Forge & Ordnance Co., Irvine, Warren Co., Penna.

U-1008 **60-cps. Stroboscope.** Bulletin B-18A illustrates and describes maker's small, inexpensive stroboscope that produces 60 flashes per sec. when connected to 60-cps. power line. Includes features and specifications.—Berkshire Laboratories, Lincoln, Mass.

U-1009 **Height Gage.** 4-page Circular 555 illustrates and describes maker's portable "Electrolimit Height Gage" comprising gage head, stand, and instrument cabinet. Includes features, specifications, and applications in inspection and manufacture.—Pratt & Whitney, W. Hartford 1, Conn.

U-1010 **Precision Level.** 4-page Circular 544 illustrates and describes maker's 15-inch precision level for determining level of bed ways, work surfaces, etc. Includes construction and features.—Pratt & Whitney, Hartford 1, Conn.

U-1011 **Coating Thickness.** 6-page folder describes theory and operation of "Coatingage Model 600" used to measure thickness of nonmagnetic coatings on magnetic bases, and to detect pin-holes in non-conductive coatings on conductive bases. Includes principles, operation, and instructions.—Branson Instruments, Inc., 430 Fairfield Ave., Stamford, Conn.

Chemical Laboratory

U-1012 **Petroleum-products Testing-lab Equipment.** 5-page mimeographed

catalog announces extensive line of petroleum-products testing apparatus (86 items), designed to ASTM and Federal specifications. Included is distillation apparatus, cold-test apparatus, viscosimeter baths, etc.—Technical Equipment Co., 4348 San Pablo Ave., Emeryville 8, Calif.

U-1013 **Molecule Models.** 4-page reprint of article "Modeling Molecules" by Dr. Douglas G. Nicholson, gives history and analysis of atom models. Includes commercially available atom models and special models devised by university staffs.—Fisher Scientific Co., 717 Forbes St., Pittsburgh, Penna.

U-1014 **Laboratory Planning Kit.** Folder kit contains 21 scaled cut-outs of steel laboratory furniture units, permitting custom installations of laboratory rooms. Heights and utilities can be marked on plan. Included are graph paper, scaled cut-outs, dimensional booklet, catalog of unitized furniture, and photographs of suggested installations.—Fisher Scientific Co., 717 Forbes St., Pittsburgh 19, Penna.

Gas Analysis and Detection

U-1015 **Gas Analyzer.** 2-page Bulletin GM-952 illustrates and describes new small "Gasmaster" gas analyzer that uses thermal-conductivity cells. Includes construction and typical specimen run.—Gow-Mac Instrument Co., 22 Lawrence St., Newark 5, N. J.

U-1016 **Gas Detector, Indicators, Alarms.** 4-page illustrated Form FSE-1251 describes four types of combustible gas protective instruments—(1) portable indicator into which suspected vapor is drawn by means of an aspirator bulb and long probe, (2) portable audible alarm which maintains continuous guard against combustible gas, (3) and (4) combustible gas alarms for fixed locations. Includes styles, principles, accessories, and spare parts.—Johnson-Williams, Ltd., 2613 Third St., Palo Alto, Calif.

Data Analysis

U-1017 **Data Analysis.** 4-page brochure illustrates and describes company's facilities for engineering and designing of data-recording, data-conversation and data-printing systems.—Data Engineers, Inc., 4608 N. Ravenswood Ave., Chicago 40, Ill.

U-1018 **Automatic Data Processing.** 8-page brochure illustrates and describes maker's automatic data recorder that presents measurements in page form, in columns and rows. Includes principle, features, technique, specifications, and typical applications.—Metrotype Corp., 525 W. 76th St., Chicago 20, Ill.

U-1019 **Slide-rule Selector Chart.** Illustrated Form 145A is chart showing scales, scale characteristics, and standard models for rapid selection of slide rule needed. Includes construction features of maker's rules.—Pickett & Eckel, Inc., 7 S. Wabash Ave., Chicago 3, Ill.

Motors and Servos

U-1020 **Motors and Servo Components.** 12-page Form 6/52 illustrates and describes maker's line of precision control motors, induction generators,

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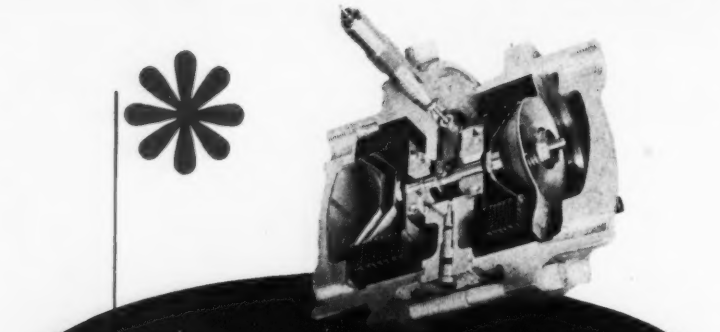

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NEW LITERATURE

miniature gear trains, and servoamplifiers. Includes physical and electrical characteristics.—Transicoil Corp., 107 Grand St., New York 13, N. Y.

U-1021 **Synchronous Motors, Instrument Movements.** 8-page illustrated Bulletin IS-120 describes large line of synchronous motors and instrument movements. Includes specifications for 16 types, a selection guide, and features and applications.—Telechron Dept., GE, Ashland, Mass.

Motor Control

U-1022 **Motor-speed Control.** 8-page illustrated Form 792-A describes line of "Variac" speed controls for d-c. motors, consisting of autotransformer and rectifier. Includes principles, features, and typical applications in manufacturing and precision operations.—General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.

U-1023 **Starters, Contactors.** 4-page Vol. 1 No. 6 issue of "Furnas News" features descriptions of new production items (rotating limit switch, 10-hp. starters and contactors, d-c. starters and contactors) and flange-mounted controls for neat appearance.—Furnas Electric Co., Batavia, Ill.

Valves

U-1024 **Control-valve Design.** 16-page booklet "New Techniques in Control Valve Design" points out industrial requirements and design criteria of various types of control valves.—Conoflow Corp., 2100 Arch St., Phila. 3, Penna.

U-1025 **Valves—Magnetic, Shut-off, Check.** 42-page illustrated brochure describes 19 general-purpose, corrosion-resistant, and rocket-engine valves, including magnetic, solenoid, acid drain, propellant shut-off, and check valves for hydrogen peroxide, liquid oxygen, etc. Includes specifications.—Marotta, Bridgeport Thermostat Div., Robertshaw-Fulton Controls Co., Birdgeport 1, Conn.

Tubing

U-1026 **Aluminum Tubing.** 8-page illustrated brochure describes advantages, features, applications, and specifications of "Alcoa Utilitube" aluminum-alloy tubing. Includes installation methods.—Aluminum Co. of America, Gulf Bldg., Pittsburgh 19, Penna.

U-1027 **Pipe and Tubing Straighteners.** 8-page Technical Bulletin 52 illustrates and describes 7 case histories in which various companies solved pipe and tubing production problems. Includes specifications and principles of maker's rotary straighteners.—Mackintosh-Hemphill Co., 901 Bingham St., Pittsburgh 3, Penna.

Telemetering

U-1028 **Microwave-operated Booster Station.** 32-page Vol. 1 No. 2 issue of "Communications News" features article on unattended pipeline booster station controlled by microwave radio. Also articles on use of mobile radio by drilling contractor, oil-delivery firm, high-

way department, etc.—Engineering Products Dept., RCA, Camden, N. J.

U-1029 **Control Facilities for Point-to-Point Radio.** 8-page Vol. 1 No. 7 issue of "The Lenkurt Demodulator" features article on "Supervisory, Control and Alarm Facilities For Point-to-Point Radio Systems." Also article on "Group Modulation and Frequency Allocations For New Type 45A System." Includes principles and block diagrams.—Lenkurt Electric Co., San Carlos, Calif.

Electrical & Electronic Test Instruments

U-1030 **Electronic Equipment and Components.** 236-page illustrated 1953 catalog describes 18,000 electronic items for scientific and industrial maintenance, research, and production—tubes, test instruments, voltage stabilizers, transformers, resistors, capacitors, printed-circuit components, transistors, rheostats, relays, switches, rectifiers, fuses, tools, etc.—Allied Radio Corp., 833 W. Jackson Blvd., Chicago 7, Ill.

U-1031 **General-purpose Oscilloscope.** 12-page Bulletin A-04-A presents new "Type 304-A Oscillograph" with high sensitivity and built-in voltage-measuring calibrating system. Includes features and specifications.—Allen B. Du Mont Labs., Inc., 1500 Main Ave., Clifton, N. J.

U-1032 **Oscilloscopes, Generators, Amplifiers.** 8-page illustrated Short Form Catalog 5207 gives specifications and features of maker's line of oscilloscopes (seven models), square-wave generators, time-mark generators, waveform generator, d-c. amplifier, and preamplifiers.—Tektronix, Inc., P. O. Box 831, Portland 7, Ore.

U-1033 **Impedance Bridges, Amplifier,** 4-page brochure illustrates and describes universal impedance bridge and bridge null amplifiers for precise measurement of resistance, capacitance, inductance, and dissipation or storage factor. Includes principles, features, operation, and specifications.—Brown Electro-Measurement Corp., 4635 S. E. Hawthorne Blvd., Portland 15, Ore.

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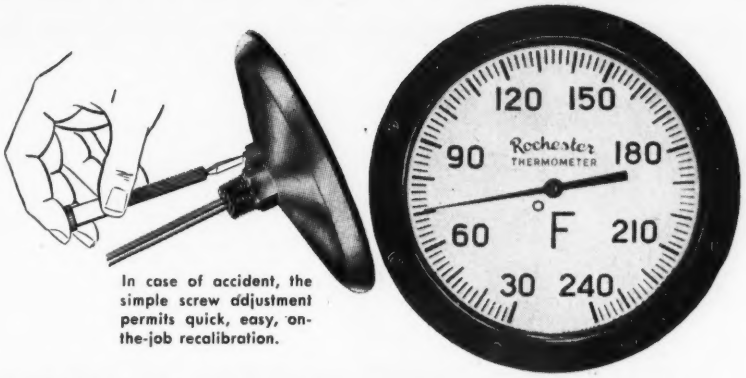
U-1034 **Power Supplies.** 8-page illustrated Bulletin ECB-6 describes 14 power supplies, regulated and unregulated. Includes electrical and mechanical specifications and new "Model ST-9A" dual regulated supply.—Electronics Div., General Electric Co., Electronics Park, Syracuse 1, N. Y.

U-1035 **Capacitance Bridge and "Guard Circuit."** 6-page Vol. 27 No. 3



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issue of "The General Radio Experimenter" features article on a capacitance bridge with fifth terminal, or "guard circuit," for direct measurement of impedance between two points of a 3-terminal network. Includes principles, circuit considerations, and specifications. —The General Radio Co., Cambridge, Mass.

U-1036 **Capacitance Measurement.** 16-page issue Vol. 17 No. 8 of "The C-D Capacitor" features 5-page article on capacitance measurement by substitution methods. Also descriptions of maker's capacitors and "Radio Trading Post" section.—Cornell-Dubilier Electric Corp., Hamilton Blvd., S. Plainfield, N. J.

U-1037 **Snap-around Volt-ammeters.** 2-page folder Insert 130 illustrates and describes features and specifications of "Amprobe" snap-around volt-ammeters. —Pyramid Instrument Corp., Lynbrook, N. Y.

U-1038 **Electronic Test Equipment.** 32-page catalog "Daven Laboratory Equipment" contains descriptions and specifications on maker's attenuation networks, decade resistance boxes and individual resistance units, volume level indicators, transmission measuring sets, noise and distortion meters, and output power meters.—The Daven Co., Dept. LE, 191 Central Ave., Newark 4, N. J.

U-1039 **Tube Testers.** 4-page illustrated Form TT5 10951 covers maker's line of dynamic mutual conductance tube testers. Includes specifications of ten models and testing principle.—The Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland 8, Ohio.

U-1040 **Ruggedized Panel Indicators.** 4-page illustrated Form RM4523 describes new ruggedized line of permanent-magnet moving-coil meters with case diameters of 2½, 3½, and 4½ inches, and ranges from 50 ua. to 5 ma. Includes construction features.—The Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland 8, Ohio.

U-1041 **Test-equipment Kits.** 12-page illustrated brochure describes over 30 kits for electronic test equipment, including wide-band oscilloscope, VTVM, Q Meter, etc. Includes features, specifications, and accessories.—Heath Co., Benton Harbor, Mich.

U-1042 **Tuning-fork Frequency Standards.** 38-page catalog contains technical bulletins which illustrate and describe maker's bimetallic forks, temperature-compensated fork-controlled oscillators, bimetallic-fork-controlled frequency standards, aluminum-alloy forks, audio-visual sound-level forks, and aluminum-alloy tuning bars. Includes specifications and accessories.—Riverbank Laboratories, Geneva, Ill.

U-1043 **Pulse-marker Generator.** 2-page illustrated Bulletin B-1B describes maker's "Labmarkers" which convert sine waves into timing pulses for oscillography. Includes features and specifications.—Berkshire Laboratories, Lincoln, Mass.

U-1044 **Phase Standard.** 4-page

"Laboratory Report No. 5," featuring "A Primary Phase Standard Assembly," describes new instrument for producing two voltages with phase relation adjustable to a precision of 0.03 degree. Includes theory and circuitry.—Technology Instrument Corp., 531 Main St., Acton, Mass.

U-1045 **Continuity and Leakage Tester.** Illustrated bulletin describes portable "Auditone" tester that uses audio tone to check circuit resistance from 0 ohms to 100 megohms, without vibrator or tubes. Includes features.—Peschel Electronics, Inc., 13 Garden St., New Rochelle, N. Y.

U-1046 **Mechanical Band-pass Filter.** 20-page Summer, 1952 issue of "Collins Signal" features article on new mechanical filter using magnetostriction elements to give narrow bandwidth at 455 kc. Other articles are on commercial cyclotron and emergency amateur-radio network.—Collins Radio Co., Cedar Rapids, Iowa.

U-1047 **Hi-pot Test, Fault Locator.** 4-page bulletin illustrates and describes maker's d-c. high-potential test and cable-fault locating set, a combination unit for testing cables and locating faults. Includes principle, operation, features, components, and ratings.—Peschel Electronics, Inc., 13 Garden St., New Rochelle, N. Y.

Electrical & Electronic Components

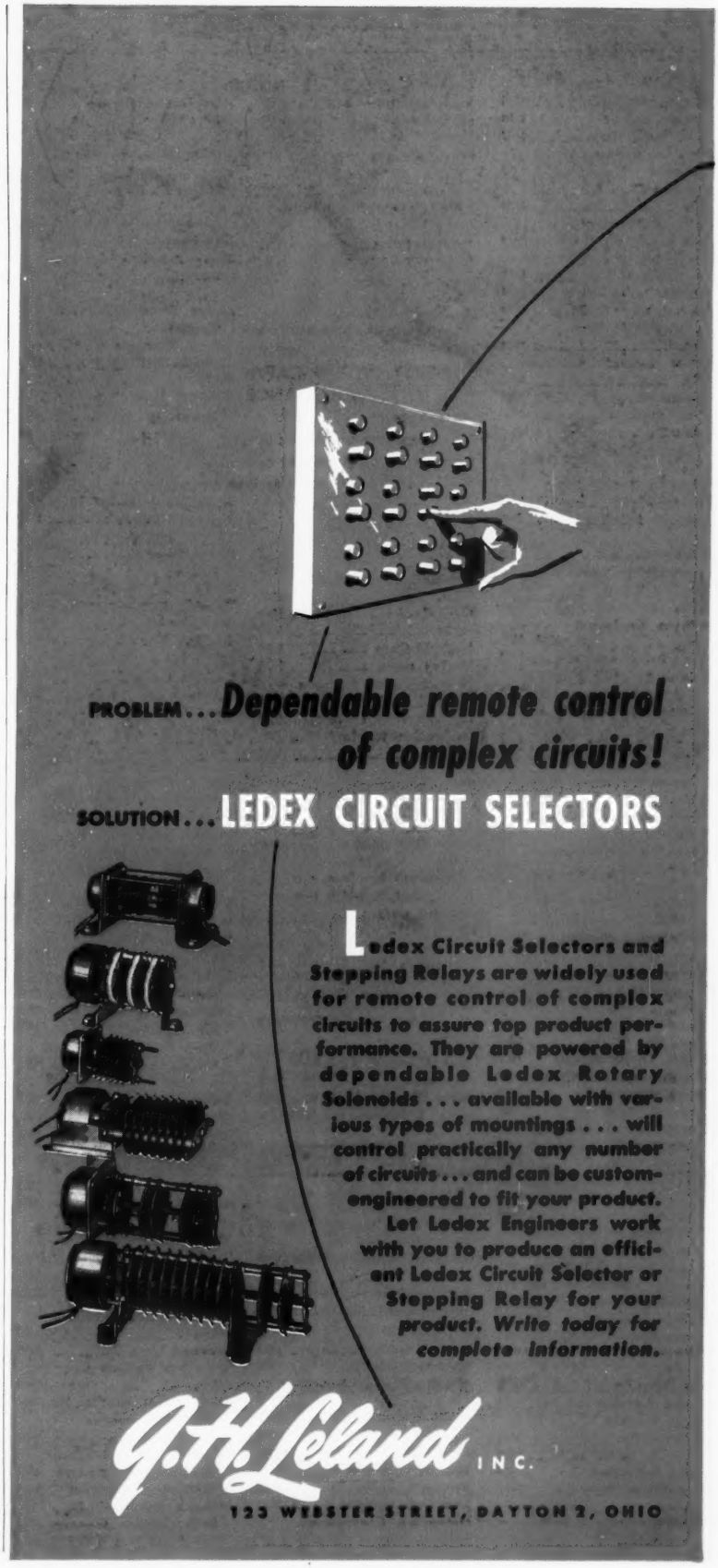
U-1048 **Precision Resistors.** 2-page Bulletin R illustrates and describes new "Series E" fixed, noninductive, wirewound precision resistors on ceramic bobbins. Includes temperature characteristics and prices.—Hycor Co., Inc., 11423 Vanowen St., N. Hollywood, Calif.

U-1049 **Vitreous-dielectric Capacitors.** 4-page brochure illustrates and describes "Vitramon" vitreous-dielectric monolithic-structure capacitors with high temperature-stability, ruggedness, low dielectric-loss, and small size. Includes features, construction, and characteristic curves.—Vitramon, Inc., Box 544, Bridgeport 1, Conn.

U-1050 **Precision Pots, Rheostats.** 2-page illustrated brochure describes new "Dekapots" and "Dekastats" that feature scale-length equivalent to a 100-turn potentiometer and high linearity, accuracy, resolution, etc. Includes principle and specifications.—Brown Electro-Measurement Corp., 4635 S.E. Hawthorne Blvd., Portland 15, Ore.

U-1051 **Precision-potentiometer Noise.** 4-page Laboratory Report #6 features article "Precision Potentiometers and Noise" by Joseph R. Atieri, and the application of the "Ponogometer" production noise tester. Includes causes of potentiometer noise, and advantages of "Ponogometer."—Technology Instrument Corp., 531 Main St., Acton, Mass.

U-1052 **Precision Transformers, Reactors.** 8-page illustrated catalog covers maker's line of precision low-frequency (down to 0.1 cps.) transforms and reactors, including input, interstage, output, and new miniature transformers. Features and specifications are given for more than 80 models.—Southwestern Industrial Electronics Co.,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NEW LITERATURE

Inc., 2831 Post Oak Rd., Houston 19, Texas.

U-1053 **Precision Switches.** 24-page Catalog 82 of precision snapaction switches covers safety, limit, and interlock switches designed especially for switching a-c. circuits in industrial and commercial applications. Other products included are explosion-proof, splash-proof and ultra-small switches. Includes description, dimensions, characteristics, capacities, and application ideas.—Micro, Minneapolis-Honeywell, Freeport, Ill.

U-1054 **Mercury Switches.** 2-page issue Vol. 1 No. 1 of "Mercury Pool" contains information about Honeywell mercury switches, their features, uses, and new designs, including characteristics, typical samples, and applications.—Micro, Minneapolis-Honeywell, Freeport, Ill.

U-1055 **Mercury-plunger Relays.** 12-page Catalog 17 illustrates and describes maker's non-tilting maintenance-free mercury-plunger relays. Includes principle, types, and applications.—H. B. Instrument Co., 2633 Trenton Ave., Philadelphia 25, Penna.

U-1056 **High-rate-discharge Cells.** Bulletin announces new "Silvercel Models HR-3, HR-40, and HR-40 NS" small, high-rate-discharge storage cells. Includes physical and electrical characteristics.—Yardney Electric Corp., 105 Chambers St., New York 7, N. Y.

U1057 **Attenuators.** 68-page illustrated catalog describes wide variety of controls, including radio-frequency attenuators, special units for precision measuring equipment, tone-compensating attenuators, stereophonic controls, and "T", balanced-"H," ladder and potentiometer-type audio attenuators. Includes terminology, principles, and specifications.—The Daven Co., Dept. GI, 191 Central Ave., Newark 2, N. J.

U-1058 **TV Fuse Guide.** Data card, printed on durable enamel stock, lists brand name, model no., and fuse requirements on all makes and models of TV.—Littlefuse, Inc., 1865 Miner St., Des Plaines, Ill.

U-1059 **Solderless Terminals.** 24-page dramatically illustrated brochure, "The Harrisburg Story," describes origin, growth, business philosophy, and engineering principles of solderless-terminal company.—Aircraft-Marine Products, Inc., 2100 Paxton St., Harrisburg, Penna.

U-1060 **Pilot Lights.** 16-page Form L-151 contains illustrations and descriptions of hundreds of pilot-light assemblies; a selected listing from maker's extensive "Dialco" line.—The Dial Light Co. of America, 900 Broadway, New York 3, N. Y.

Engraving

U-1061 **Engraving Machines.** 6-page folder Bulletin B-1 illustrates and describes maker's line of engraving machines and accessories, including "Electro-Marker" cutter-grinder, work table, and endless belts.—H. P. Preis Engraving Machine Co., Hillside, N. J.